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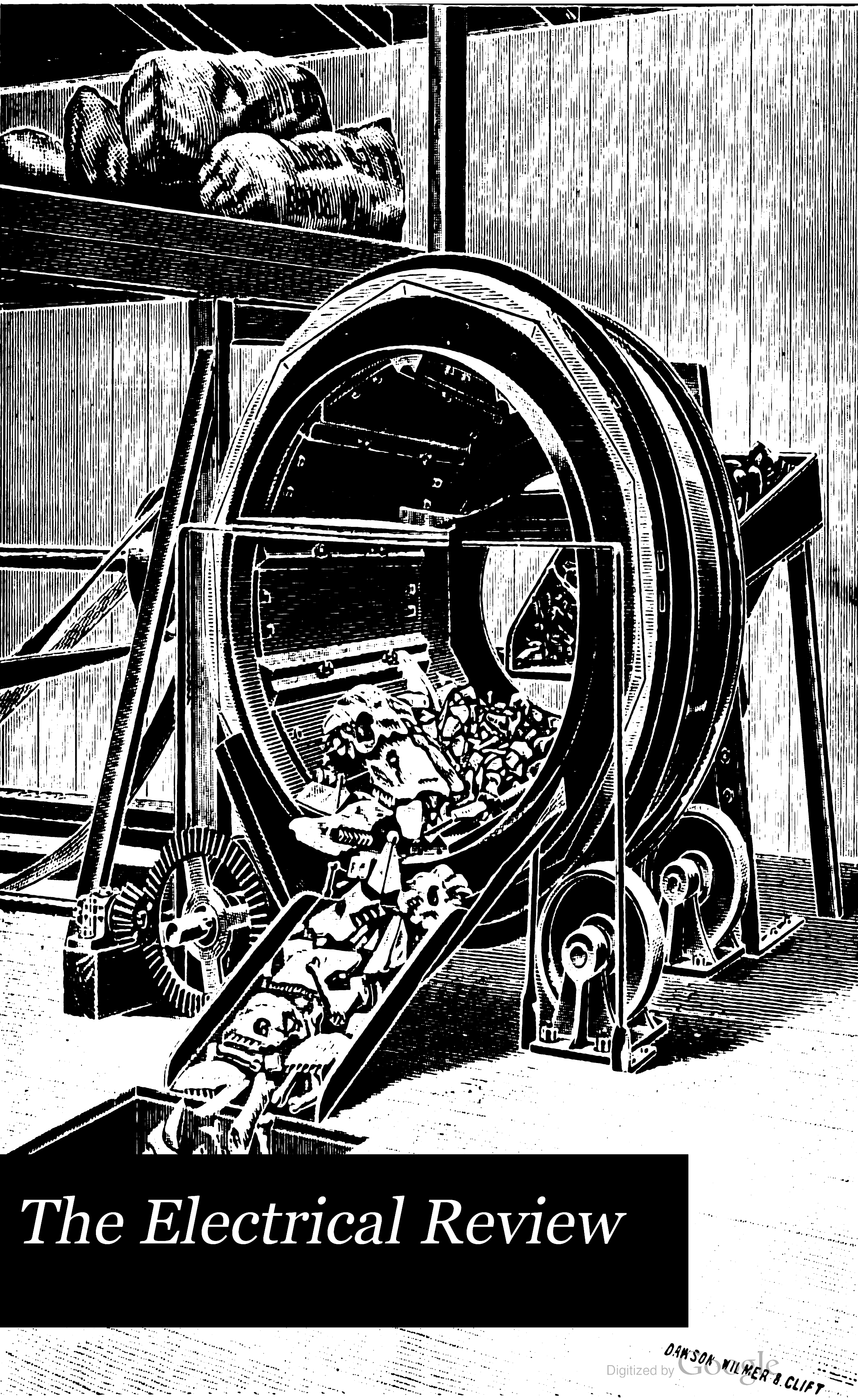

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THE

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NOTES.

Kidderminster.—The Bill confirming the Kidderminster electric lighting has been passed.

Carbon Trusts.—It is stated that a "trust" is being formed of the principal American electric carbon manufacturers.

Dover.—We may remind electrical engineers that the tenders for Dover electric lighting are to be sent in on the 10th inst.

Whitby.—The Bill for confirming the provisional order for Whitby has been ordered for second reading in the House of Lords.

Steam Separators.—Prof. Carpenter, of Sibley College, Cornell University, has recently carried out a series of experiments on the efficiency of steam separators.

Sales.—Our readers will notice the continued advertisement of sales of plant at the Albert-embankment and Quintin Matsy's Forge, to which we have already called attention.

French Cables.—The *Times* correspondent states that in the French Senate on Wednesday a grant of 5½ millions for cables between Marseilles and Tunis and Marseilles and Oran was agreed to.

Cardiff.—Messrs. Gilbert and Co., Hanway-street, W., have secured the contract for a complete installation at Messrs. Hopkins, Market, Cardiff, with a large number of arc and incandescent lamps.

Edinburgh Exhibition.—A second dividend, making 16s. in the pound, has been paid by the liquidator of the Edinburgh Exhibition. The materials are being sold, and a further dividend will be declared.

Telegraph in Scotland.—The Post Office extensions of the telegraph go on from time to time, reaching further and further into remote districts. One of the latest of these is to Pitlochry and Loch Tummel.

Bridge Lighting in London.—The Bridges Committee of the London County Council find there is not sufficient light on the bridges crossing the River Thames, and extra burners are to be added at the cost of £100.

Winslow (Bucks.).—The electric light was tried at Winslow on Friday evening last, when it proved a great success. Gas directors will have to take less for their gas, or, it is thought, it will not be required for the coming winter.

Swiss Electric Launch. — The Oerlikon Works, together with MM. Escher-Wyss, have built an electric boat, which has recently been launched on "Zurich's bright waters." The boat is capable of running six hours continuously, at eight miles an hour.

Spanish Cables.—Submarine cables have been laid successfully between Tarifa and Tangiers, and between Tunara, a fishing village situated eastward of the Spanish lines, and Cueta, the Spanish settlement on the Moorish side of the Striats of Gibraltar.

Selby.—Contracts are required for the lighting of the public lamps of the town, by the Selby Local Board. The prices are to be per lamp, from August 1, 1891 to May 31, 1892. Tenders to be sent in by July 3 to Mr. J. H. Bantoft, clerk, Finkle-street, Selby.

Street Lighting in France.—In reference to the paragraph under this heading last week, we are informed that the installation carried out by M. Clomançon, of Paris, is on the Bernstein system, the lamps having been supplied by the Bernstein Electric Lamp Company.

Accrington.—The Markets Committee of the Accrington Corporation have recommended the Town Council to introduce the electric light at the Town Hall, and also to consider the powers granted to the Corporation for a further extension of electric lighting within the borough.

Telephone Patents.—Our readers will notice that the National Telephone Company are calling attention to the fact that all their patents do not all expire this month, and that proceedings will be taken against persons making transmitters upon the patents which do not expire till 1892 or 1893.

Birmingham.—Mr. Charles A. Smith, of the Athenæum, 71, Temple-row, Birmingham, has been appointed agent to Messrs. Woodhouse and Rawson for Birmingham and district, and has opened showrooms at the address given, where samples of goods may be seen, as well as local orders executed from stock.

Storage Cars.—A successful electric storage car system is reported in operation in Dubuque, Iowa. After years of investigation, Mr. Rhomberg, the president of the line, has instituted this system. The cars run at 10 miles an hour, and swifter cars are to be put into operation. The Accumulator Company's batteries are used.

Cricket.—A friendly game was played on Saturday at The Elms, Acton, in a field adjoining the works of Mr. Ronald Scott, between an eleven got up by Mr. Scholey, of the *Electrical Review*, and an eleven from the works of Mr. Ronald Scott. A very enjoyable afternoon was spent, and we are informed that the return match will be played on the 25th inst.

Duke of Hamilton's Telephone.—The telephone which connects Brodick Castle and the Duke of Hamilton's shooting lodge at Doughie with the chamberlain's house and postmaster's house at Brodick was satisfactorily completed on Saturday. The work has been executed by Messrs. Cox, Walker, and Co., electrical engineers, Edinburgh and Darlington.

Queen Anne's Mansions.—A separate company has been formed to light the Queen Anne-mansions. It has been pointed out that the London Electric and the West-cables. There were several steam engines, a Worthington pump, a small alternate-current dynamo, and a model of Brotherhood's three-cylinder engine and pump in motion; whilst numerous models and photographs of Joy's valve gear, Giffard injectors, Kennedy's water-meter, brickmaking machine, torpedo, Holden's liquid fuel injector, Donkin's sprung piston rods, gas exhauster, fourway valve, and Sulzer valve gear, Hero, Newcomen, and Savory engines, a cylinder of Robey engine, with automatic valve gear, represented various branches of mechanical engineering. The laboratory testing machine, capable of exerting a pull of 100,000lb., was described, and the method of testing demonstrated; numerous tests in tension, compression, shear, and bending being displayed. The method of testing cement was fully illustrated. The engineering laboratory formed a centre of attraction throughout the evening.

Teague's Meter.—We drew attention at the time of the St. Pancras Exhibition to a new electric meter invented by Mr. Francis Teague, of Acme Electric Works. This meter promises extremely well, and has great points of advantage. Several improvements have been made in details, and it is expected, we believe, that it will be ready for the market in a few weeks. The meter is a simple embodiment of Faraday's experiment. A magnet has a large hole pierced in one of its poles, and in this the other pole projects, leaving a thin space between the solid and hollow poles, having a most intense magnet field. In this a thin metal cylinder, which carries the current, rotates by reaction of current and magnetism. The cylinder is mounted on jewelled points, and gears into a worm with dials reading direct in B. T. units. The meter has received improvements in a metal frame to prevent all warping; also the rotation of the cylinder has been damped by suitable arrangements, so that its greatest speed now is about equal to 100 revolutions only in the minute for 50 amperes. The meter, one of which we saw tested, starts very slowly, but regularly, at a current of ·2 ampere, less than that required for an 8-c.p. lamp. The motion is very sensitive, starting immediately and stopping absolutely dead when the current is turned on or off. It has only one moving part—the cylinder—besides the train of wheels, and these move so slowly that there is not much danger of wear and tear. Both wheels and pinions are made of brass to prevent any inconvenience from rust in damp places. The only possible objection is the mercury contact, and the hole through which the spindle rests is so small, and is, again, closed in by the cover, that no dust could get in. It has been carefully tested, and is correct to within 2 per cent. the whole way up from 1 to 100 lamps. Teague meters are being tested at the Pall Mall, Westminster, Kensington Court, and Chelsea stations. We expect to hear more of this meter, which is simple and should be cheap.

City Electric Lighting Bill.—The Parliamentary Committee of the London County Council report with reference to the Bill granting a provisional order for the City of London. The Bill contains a clause authorising the transfer to a single company of the undertaking of the two companies (Brush and Laing-Wharton) authorised to supply in the City of London, and also the undertaking proposed to be authorised in the district of St. Saviour, Southwark, in which the station for generating electricity to be supplied to the City of London will be situate. It is obvious, says the Parliamentary Committee, that on any such transfer some complication may arise by reason of the fact that the County Council have the appointment of inspectors generally in the county of London, and the Corporation have the appointment within the City. Moreover, the enactments in the orders within the City do not in some respects correspond with those in force outside. A difficulty also would arise in connection with the question of purchase. As the time for lodging the petition expired on the day of our meeting, the committee sanctioned the presentation of a petition, which has accordingly been presented. The attention of the Board of Trade has already been directed to this clause in their orders, but think the clause should be retained, and have retained it, so that if the petition is proceeded with it becomes rather a question of opposition to the Board of Trade by the London County Council. The clause in question provides that any transfer under the terms of it shall be on such terms and conditions as the Board of Trade impose, and the committee understand that the Board of Trade think that this would be sufficient to enable them to deal with any question which might arise. The deputy-chairman and the chairman of the Highways Committee have been requested to seek an interview on the subject with the proper official of the Board of Trade, and if satisfactory arrangements can be made, the petition may be withdrawn. In the meantime it was recommended that the course taken in presenting a petition against the Bill be approved.

City Lighting.—The Streets Committee of the Commissioners of Sewers at last week's meeting brought up a report recommending the Commission to consent to the proposed transfer of the undertakings in regard to the electric lighting of the City to a new company to be formed under the title of "The City of London Electric Lighting Company." Mr. J. L. Sayer, chairman of the committee, said that at the time the contracts were entered into it was known that they would involve an outlay of at least a million, and that the contracting companies would either have to borrow the money or form a syndicate. Mr. Morton, M.P., asked what promotion money was to be paid. They had had the experience of the Hansard Union, which was floated entirely upon the House of Commons contracts, and his opinion was that the name of the Commission had been sufficiently used already by the companies without it being further used for Stock Exchange purposes. Mr. C. T. Harris said he had ascertained that the Brush Company would receive £310,700, and the Laing, Wharton, and Down syndicate £237,000, from the proposed new company. He moved an amendment to delay the assent to the transfer of the contracts until more detailed information was forthcoming, urging that the provision for a reduction of the charges to private consumers when a 10 per cent. dividend was earned would be sacrificed if the capital was increased. Mr. Stapley seconded. Mr. Deputy Edmeston was surprised that such information should be needed when the committee were told by the managing director of the Brush Company that no money would be paid other than for materials and for work that had been done. Mr. A. A. Wood hoped that the consumers would be properly protected. The chairman said he could give the Court the assurance of the representative of the Brush Company that not a shilling was to be paid for goodwill except for works, etc., which were to be executed. Mr. Cloudesley thought that further information should be given. Mr. Morton asked whether anyone connected with the Commission was connected with any company; he saw the name of the Lord Mayor and Messrs. Pannell and Co. on a document. He was glad to see that the Lord Mayor had withdrawn his name. Mr. Pannell said his name only appeared as an auditor. In reply to Mr. Shaw, the solicitor stated that the position of the Commissioners would be in no way prejudiced by the proposed transfer. The amendment was put and lost by 18 votes to 24, and the report was agreed to.

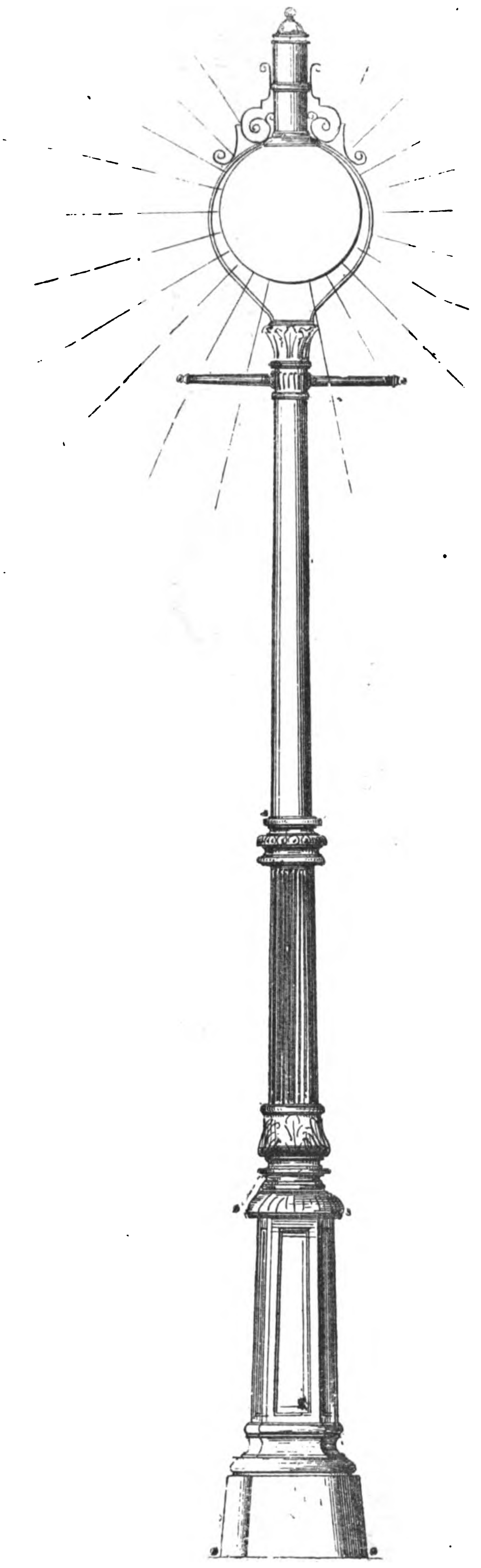

Fig. 5.

elegance of design are incompatible with the bustling activity and the narrow streets of City work. The idea that "anything" will do must be negatived, and a good example must be set to those towns that follow the lead of modern Babylon. We are amongst those who believe the engineers have not quite realised the possibilities of the case, and the temporary standards, as erected, seem a little deficient in artistic merit. An illustration of the standards erected in Queen Victoria-street hardly meets the case. They ought to be seen *in situ* to be able to decide as to their design. However, so far as illustrations will assist, we herewith give various designs of arc lamp standards. Fig. 1 shows the standard as erected in Queen Victoria-street by the Brush Company. To us the knobby excrescences are an eyesore, and rather put us in mind of an antediluvian ladder; the ornamentation and proportions of the base are also crude and inartistic. With the head of the standard we have not much fault to find, either as in Fig. 1 or as in Fig. 2, the latter of which shows the head of the standard as proposed for the portion of the City to be lighted under the Laing, Wharton, and Down Syndicate. The base and centre-piece of both standards are the same. Figs. 3 and 4 show the standards as used in Berlin; Fig. 5 is a design for a standard for the City, by Mr. W. Doubleday, of Birmingham, as is also Fig. 6.

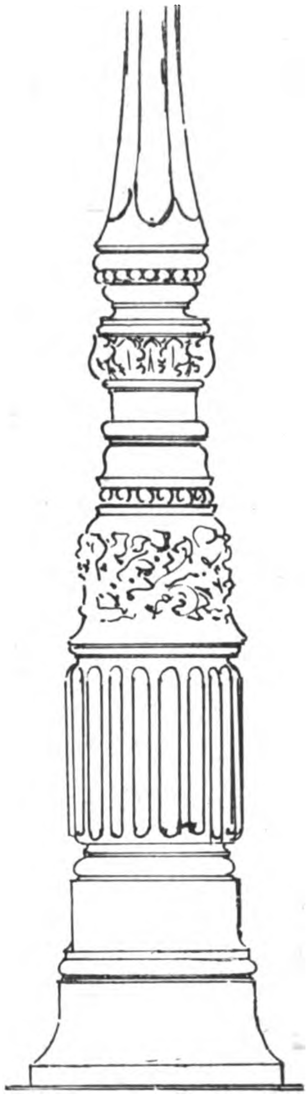

Fig. 2.

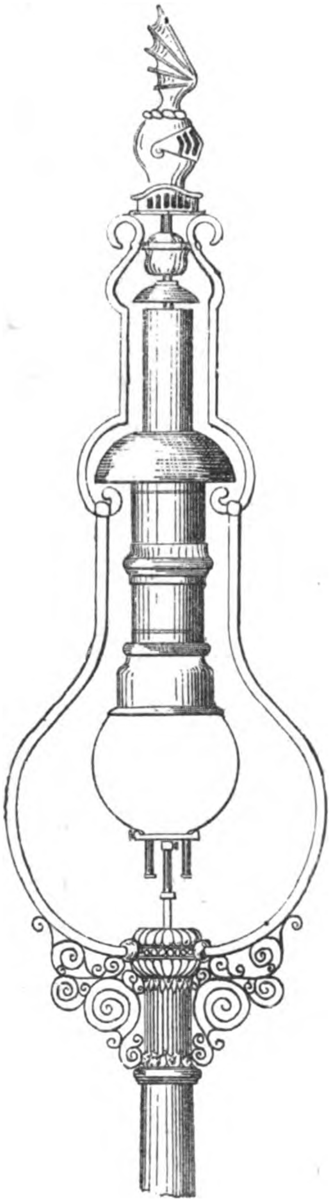

Fig. 6.

Alhambra.—At the performance of "Oriella" at the Alhambra, all the ballet electric effects have been carried out by Mr. Chas. S. Northcote, engineer to Messrs. B. Verity and Sons.

THE ROYAL AGRICULTURAL SOCIETY'S SHOW AT DONCASTER.

We have already directed attention to the prominence of oil engines at this show. In other directions the visitor could inspect motors of the most approved type, and possessing all the improvements known to the manufacturers up to date. Of purely electrical apparatus there was little to be seen. The engineers of the society, Messrs. Easton and Anderson, used a Prentice dynamo and motor, constructed by the firm, to carry on the trials in the dairy.

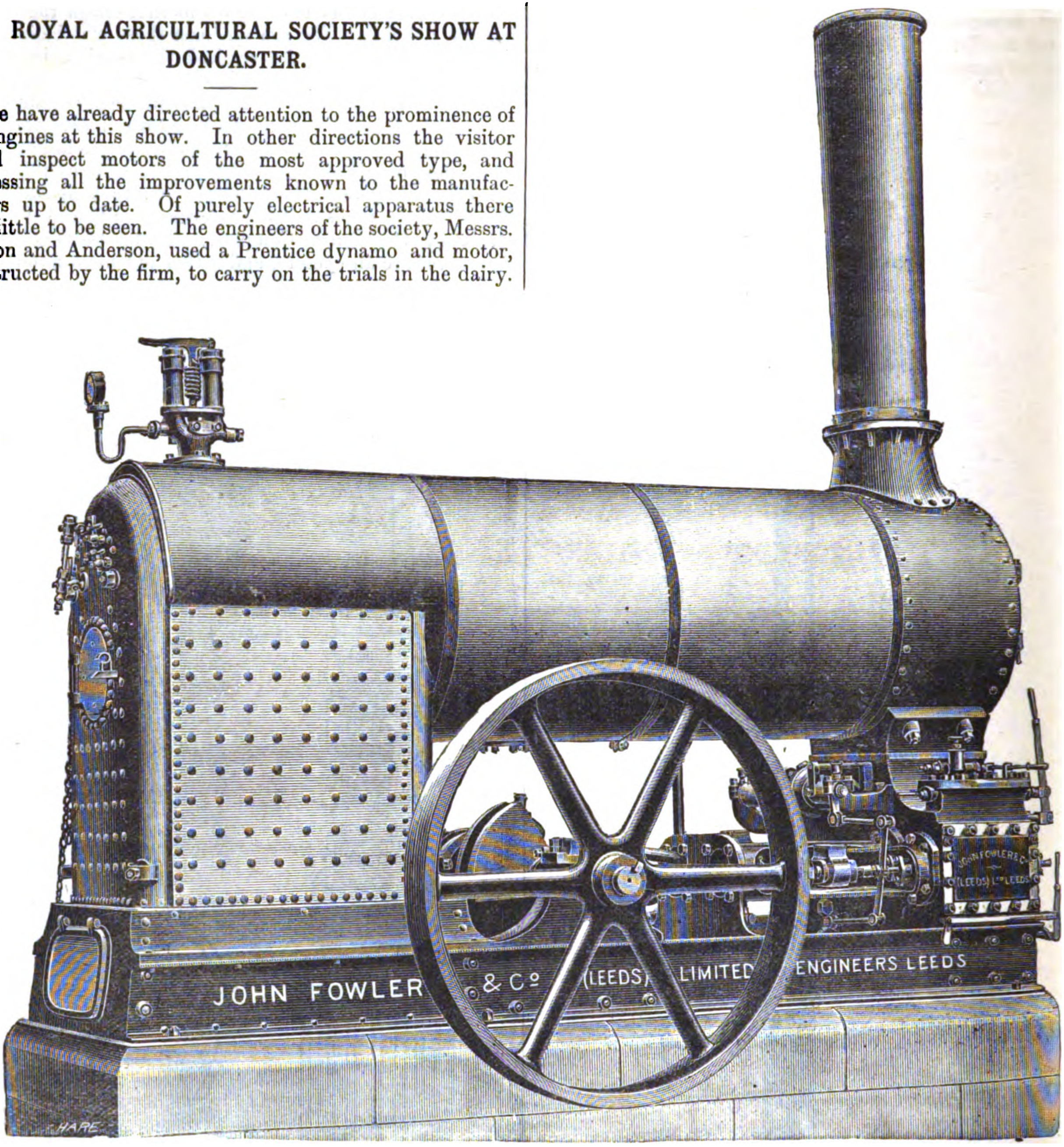
JOHN FOWLER & Co (LEEDS) LIMITED ENGINEERS LEEDS
JOHN FOWLER & Co (LEEDS) Ld LEEDS
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Fig. 1.

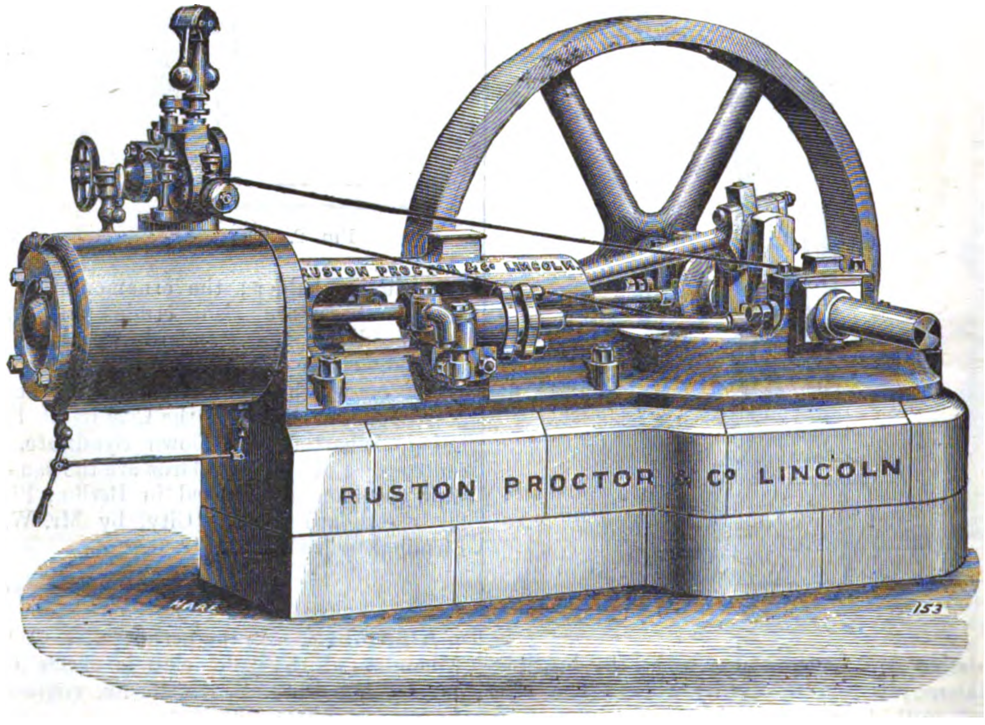


Fig. 2.

So far as we were able to judge, the apparatus was well adapted to the purpose, caused no trouble, and got rid of much objectionable shafting, enabling the trials to be carried on at any desirable point with greater facility than has usually been the case.

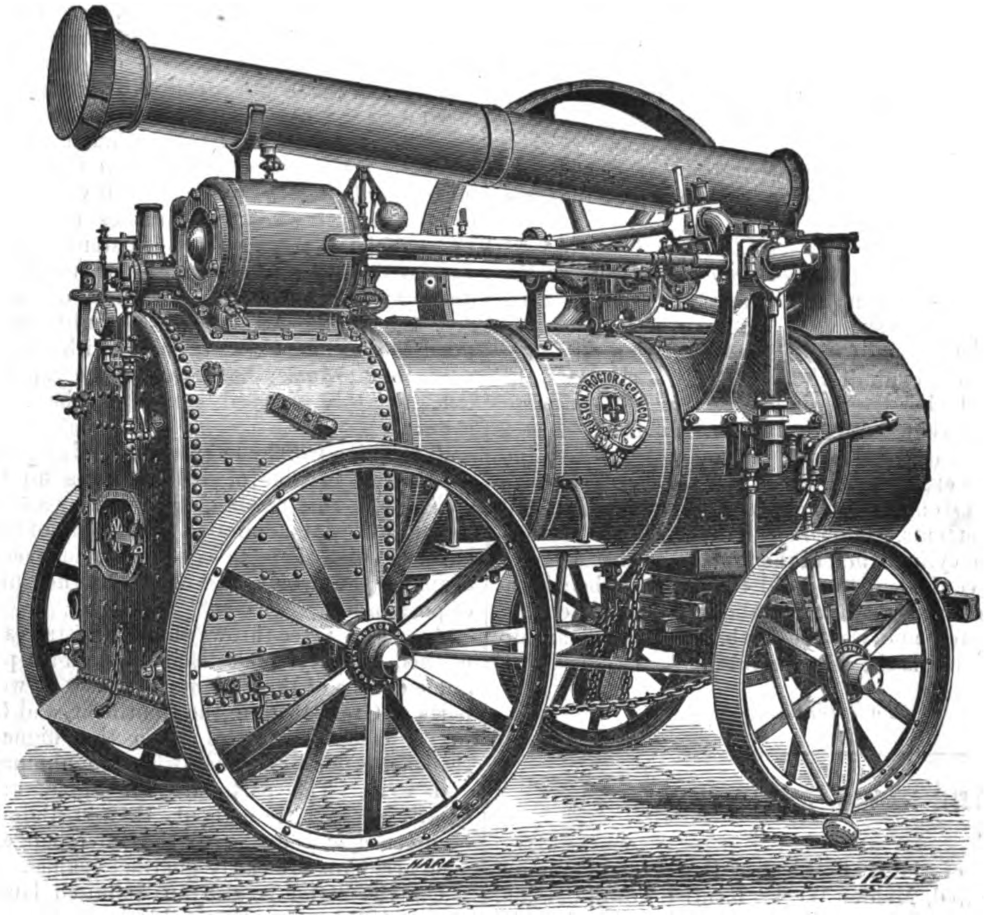


FIG. 3.

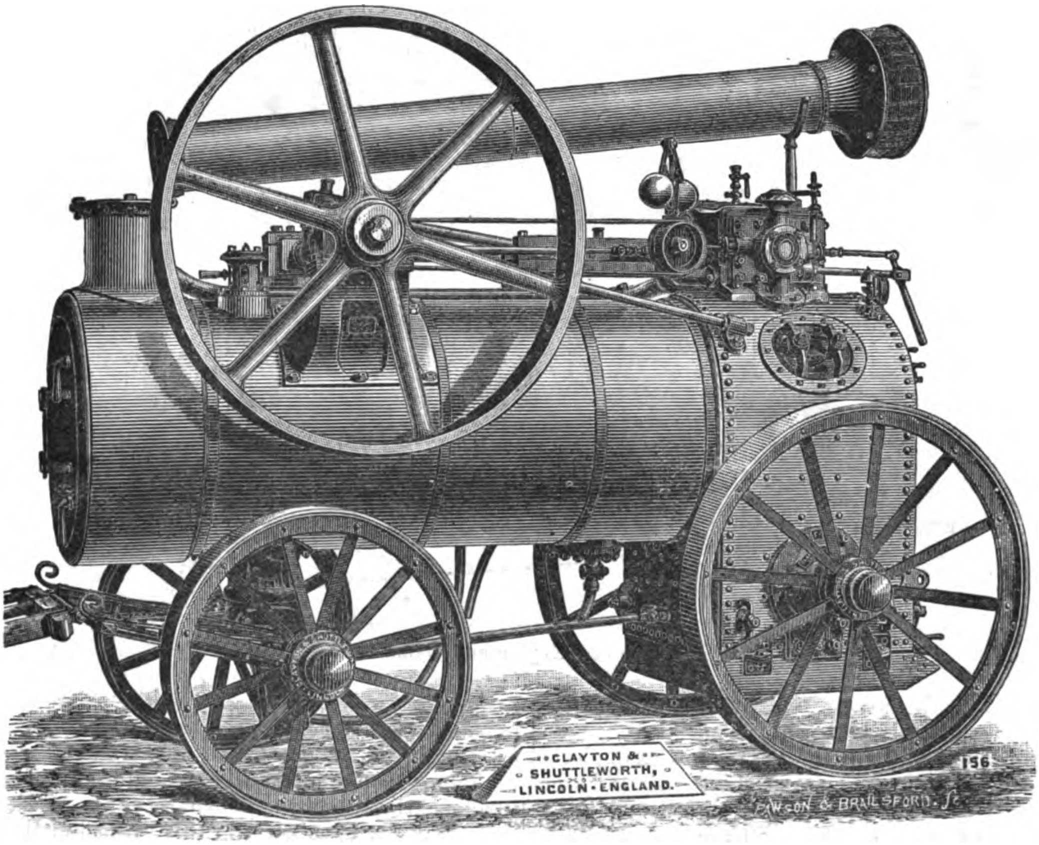
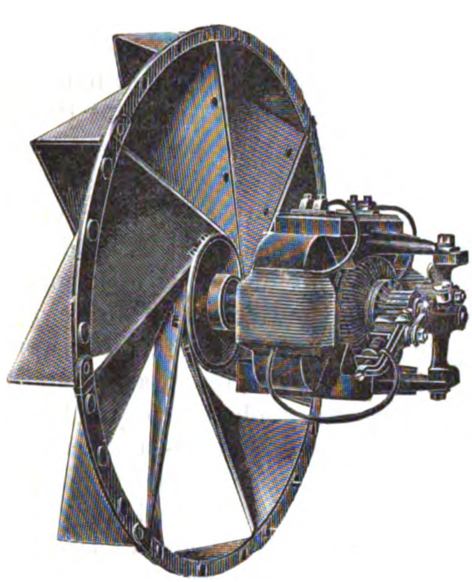
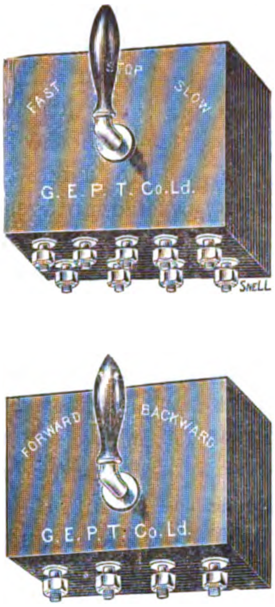

CLAYTON & SHUTTLEWORTH, LINCOLN ENGLAND.
156
DAWSON & BRAILSFORD Sc.

FIG. 4.

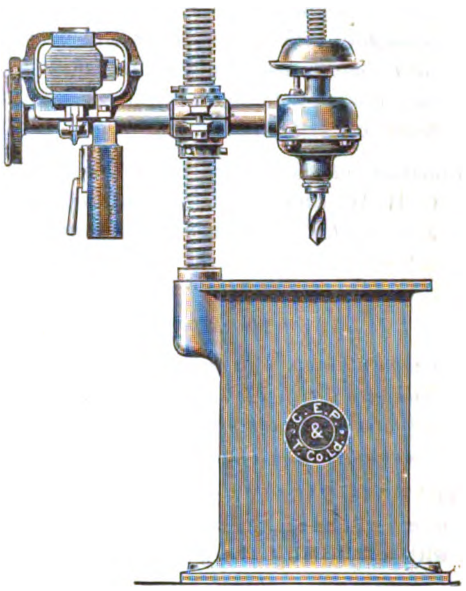
The Hardy Patent Pick Company exhibited a magnetic separator, used for the purpose of extracting iron from among crushed bones, ore, etc. The separator was, we believe, constructed by Messrs. Goolden, and was under the charge of Mr. Atkinson. The separator is conically shaped, with soft iron bars running lengthwise down the interior. These bars are wound with wire, the ends of which are carried to a commutator. The material to be treated is led into the small end of the apparatus, which revolves upon company has an electric pannace designed on the lines of the Admiralty steam pinnaces. It is 36ft. long, 7ft. beam, with a maximum draught of about 2ft. It is built in pine with oak stem, stem and stern posts, and is bright all over. The accumulators, 50 in number, are arranged in teak boxes under the seats, and are so placed as to be easily removable when necessary. The whole is so strongly built that by suitable arrangements the pinnace can be slung on davits with all electrical equipment ready for use. The cells can be charged either with the pinnace slung in the davits or moored alongside the ship. The motor is much more powerful than those usually supplied by the company for use in the launches on the Thames and at Windermere, and a speed of 11 miles per hour can be obtained for some three to four hours. Since these boats are principally used for shore purposes, speed and power have been considered of more importance than duration of run. For shore and harbour pinnaces electricity possesses many advantages over steam, and they no doubt will be largely in demand before long. These launches are ready for use at a moment's notice, and possessing none of the disadvantages of steam as regards dirt, smell, and heat, commend themselves to the consideration of all. One of these pinnaces, 40ft. long, 7ft. 9in. beam, and 2ft. draught, with a handsome teak cabin, is now being built by the T. G. Electric Power and Traction Company to the order of the Naval Department of the Russian Government; it is expected that this launch will give fully 11 miles per hour. The company have demonstrated the sea-going properties of these pinnaces; they find them to have a very steady motion even in a fairly high sea, and the centre of gravity is so well placed that the rolling is little. The motor having no reciprocating parts, runs more smoothly than a high-speed engine—this advantage will be specially felt when there is a tendency to racing of the propeller; and the whole of the electric details have been so well thought out and proved by actual experience, that there is no fear of a hitch. Since the motor and accumulator are all arranged beneath the floor and seats there is more room and greater comfort for passengers, and the carrying capacity of a given size boat is increased by about 50 per cent. The small torpedo boat running on the lake at the Naval Exhibition has been equipped by one of the company's launch motors, and the company have just received an order to build and equip a second boat of similar dimensions. The headquarters of the company's boat department are at Platt's Eyot, Hampton, where different-size launches can be seen and inspected by those interested.

There are many other interesting things to be seen at this stand, but we cannot enumerate them here; a visit should be made.

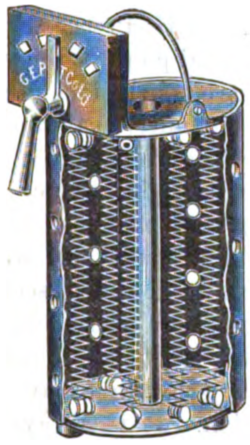

Motor and Fan.



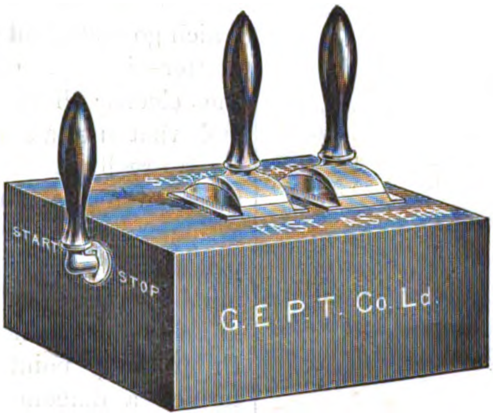
Electric Launch Switch.



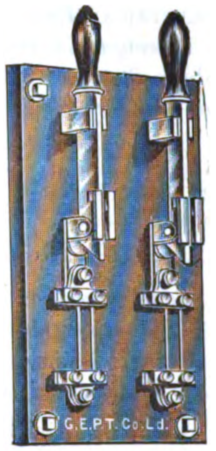
Electric Drill.



Resistance.



Electric Launch Switch.



Switch and Fuse.

The Telautograph Again.—Prof. Elisha Gray, the noted electrician of Chicago, will give a public exhibition in July of the latest invention, the telautograph, which (says a New York telegram) is destined to revolutionise telegraphy. Prof. Gray perfected the invention in 1889, after working on it for seven years, but kept the secret until the patents were secured. The instrument not only transmits the message a long distance by wire, but reproduces at the receiving point a perfect facsimile of the message as written. Pictures and diagrams may also be transmitted. The instruments will be manufactured at Highland Park, a suburb of Chicago, and branch lines will be established throughout the country.

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MUNICIPAL ENGINEERS.

One of the most important duties of municipal engineers in the immediate future will be to watch for and advise their respective authorities upon the introduction of electric light and power. A good deal of friction has in the past arisen between supply companies and local authorities. Each party was fighting for its own hand, and neither saw any common ground of action. It has been well said that as men grow older they grow wiser. The same holds true of those who promote new industries. Filled with enthusiasm at first, they imagine that everyone to whom they go should rush with alacrity to embrace the chance of displacing the old by the new. David's decision about the sword is too often forgotten. He would not use it because he had not tried it. The promoters of a new industry have the same feeling to contend against. Proof, in some way or other, must be given as to the advantages said to be obtained. The technical advisers of local authorities—that is, their engineers—knew little of electrical matters, and the exponents of the new departure knew little more. The latter had something which they swore by, but of its capabilities knew nothing. All were learners. For a time their progress was naturally slow. Satisfactory proofs gradually accumulated, and now greater activity prevails, while the outlook points to still greater development. The municipal and county engineers are therefore buckling down to the task of learning all they can about electrical progress. At their meeting last week several papers were read dealing with electric lighting from the municipal point of view. The most important of these is the address of Mr. W. H. Preece, F.R.S., which goes straight at the crucial point of the whole matter—its cost. Mr. Preece's conclusions are that the electric light has been vilely calumniated, and that instead of being the rich man's light, it is really the poor man's light. Once convince municipal authorities that the cost of this artificial light is not that of a luxury all will be plain sailing, for it is evident to the most sceptical mind that its other advantages are overwhelmingly in its favour against any other artificial illuminant. From many points of view gas might have been termed a diabolical invention. It is always dangerous—not openly, but insidiously so—although interested parties are ever commenting upon the smell preventing accidents; whilst with electricity there is no such danger signal. We have always held that the danger from explosion is the least of the dangers from gas. Its leakage propensities in minute quantities probably cause more headaches, more depression of spirits, conduce more to the lowering of tone of the system, and putting it in a condition to contract any prevailing epidemic, than all other causes combined. Putting, however, these questions aside, the municipal engineers have a solid substratum of data as regards cost to consider. Their visit to Ferranti's central station, to the City and South London Railway, would initiate them into the ractical part of the work. In this direction the ifficulties encountered have been neither few nor imple, but for the most part have been successfully vercome, so that half a dozen or half a score of ngineers would readily provide plans for the lighting f any town in the kingdom—plans which if carefully arried out would lead to perfectly trustworthy and atisfactory lighting.

VESTED INTERESTS.

The decision with reference to the Birmingham electric tramways and the telephones shows conclusively that the telephone companies will fight under the ægis of "vested interests" to obtain the monopoly of "earth return." The man in possession is a most difficult individual to deal with. Morally, his right may be objectionable, but practically he laughs at all opponents. The "earth" as a return seems naturally to come under the head of common property, just as the air we breathe; but currents do interfere with each other, and no doubt heavy currents, such as are used in tramway work, or in lighting, cannot use the same earth as telephone or telegraph currents. The case stands thus: In many places telephones have been installed, and in the majority of instances, when installed, the earth is used as the return part of the circuit. The telephone companies are private adventure concerns, and whatever profits arise go into the hands of shareholders and are not common property to the whole community like telegraphic profits. A part of the profits is paid in the shape of royalty to the Telegraph Department, and so may be looked upon as a benefit to the community, but otherwise, as we say, the adventure is one of a purely private character. Tramway work, electric lighting, electric transmission of power, are also private adventures, and from the moral point of view these adventures have just as much right to use an "earth return" as the telephone.

In no case, however, is an earth return better than a metallic return, and it is only used to save money; and this, so far as telephony is concerned, is usually saved at the expense of time and temper. The best telephone circuits are those wholly metallic. It is argued, however, that initial saving is of the utmost importance in the early stages of an industry, and that the development of telephony would be greatly retarded by insisting on the use of metallic circuits Some eminent telephone engineers dispute this, and contend that in all instances the complete metallic circuit is the best.

At Birmingham the tramway company desired to use the earth as a return, but the telephone company objected, and has won the day, in that the tramway company will have to incorporate in its Bill a clause to use a return wire. The shareholders of the tramway company, being mostly local people, are rather nettled at this decision, and a good deal of correspondence has taken place on the subject in the local Press. It will be seen, however, that the question is wider than Birmingham, and must be decided upon the wider basis. Are we to recognise the principle of "vested interests" wherever a telephone wire is installed, or is earth to be "common property," or is it to be reserved solely for the nation—*i.e.*, for the Post Office?

UNDERGROUND ELECTRIC RAILWAYS IN NEW YORK.

The question of rapid transit has been one that has been agitating the minds of engineers and municipal authorities in New York not less than in London itself. The overhead railways above the streets have made their unpleasantness abundantly felt in spite of their convenience, and further rapid transit was hardly to be looked for in this direction. Street railways with overhead conductors are equally objectionable in a large and crowded city, conduit systems have not yet shown their practicability on any scale (though they seem to promise well in this country), neither have storage cars demonstrated their absolute efficiency and economy on the scale desired. There remained the underground tube electric railway, which, without disturbing the street, has been shown by the City and South London line to give a desirable solution of the problem in point of rapidity and safety, as well as facility of obtaining the necessary space for new railway lines without encroaching on the streets. We learn that after considerable discussion, which has been going on for some months, it has just been decided to put down 20 miles of this underground tube electric railway to serve from the business part of New York to the west end suburbs. We believe it is not at all improbable, also, that a similar railway will be undertaken to give communication for the east end district.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BATH.

SIR,—On January 30 you published among your notes the following:

"BATH.—We are glad to learn that considerable and gratifying improvements have taken place at the Bath central station. The festoons of wire and other temporary arrangements that made this station somewhat like a Yankee station have given place to the neatness and solidity that should distinguish English engineering work. The high-potential terminals also—previously a source of our complaints—are now covered in with glass and out of harm's way, and matters have smoothed over considerably since the new chief engineer took up his work there"—implying that I had left the station in these particulars in a "temporary" and "Yankee"-like condition, which I deny.

By a remarkable coincidence that number of your paper never reached me, and the above was only brought to my notice a day or two ago.

At the date of your note, and for some time afterwards, the wires were in exactly the same condition as I left them a month before, as were also the switchboards, with their high-tension terminals. Therefore "the considerable and gratifying improvements" mentioned were carried out by me, and not by the new engineer, as stated.

The specialities that cannot under any circumstances be d are:

Until September 17, 1892: Powdered carbon in combina- n with a metallic or metal-covered diaphragm. Until nuary 21, 1893: Blake's method of holding diaphragm springs; Blake's special form of adjusting lever; and ake's combination of two contacts mounted on separate rings, being respectively Blake's claims Nos. 1, 3, and 4.

LIGHTING OF THE S.S. "SCOT."

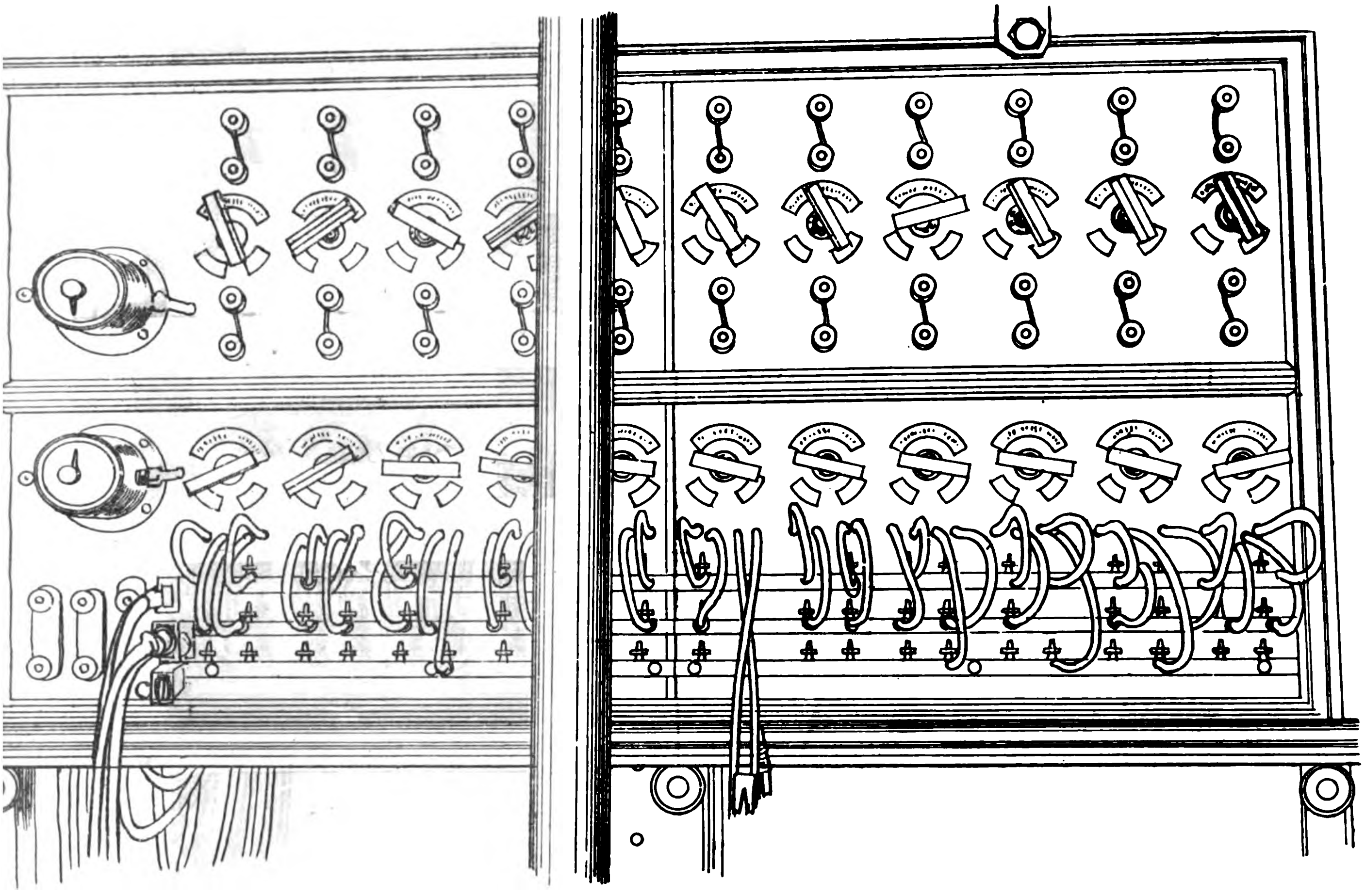


FIG. 1.

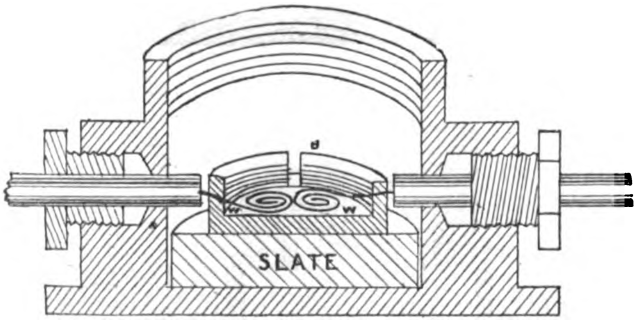


FIG. 2.

The following details of the s.s. "Scot's" electric installation will be interesting. There are 680 lamps of 16 c.p., and 10 electric fans. Two of these latter are Blackman fans driven by Crocker-Wheeler motors, and are used for extracting the foul air from the engine-room skylight. Of the other eight, which are made by Messrs. King, Brown, and Co., Edinburgh, two are downcast and supply air to the engine-room, the remainder exhaust the foul air from the cabins, etc. Current is supplied by three dynamos, by King, Brown, and Co., capable of giving about 200 amperes at 100 volts, driven direct by three compound engines, by Brown Bros., Edinburgh, at a speed of 200 revolutions per minute. Each dynamo has a tachometer attached, and the potential is measured by Sir Wm. Thomson's marine voltmeter. In the dynamo-room there is a main switchboard, Fig. 1, designed by Mr. Malcolm, Sutherland, and made in the electrical department of the Leven Shipyard, Dumbarton. It is 6ft. by 3ft., and is made of white marble steeped in paraffin. The lower part is occupied by three angle bars, which run from end to end, and to each of which a dynamo is connected through a fuse and ammeter clip. The upper portion is occupied by two rows of fuses and two-way switches, to which the fan leads and 14 main leads are attached. As has already been said, the switches are two-way, and to each of them two flexible electrodes are attached, one on each side, having clips on their ends by means of which they may be attached to any of the three bars. As each switch has two electrodes, one of which must always be idle, when it is necessary to change any circuit from one dynamo to another, the idle electrode is clipped on to the dynamo wanted and the switch reversed. In this way any circuit can be changed from one dynamo to another without interrupting the light. By means of the ammeter clips the current can be measured at any time by either of the two Siemens ammeters which have been mounted on the board. From this board the mains are led to 14 distributing-boards, also made in the shipyard works, placed in different parts of the ship. These boards contain switches and fuses, from each of which a wire is run to a group of lamps, the maximum number of which is eight. As the sectional area of the wire is kept uniform throughout, it is unnecessary to have any other fuses. Single wiring is used, except in the vicinity of the compass, where double wires are run; and to simplify the wiring, and make testing and repairs easier, soldered joints are superseded by a patent screwed junction made by W. McGeoch and Company, Glasgow, as shown in Fig. 2. This consists of a small brass pan about an inch in diameter over all, screw threaded inside, and with vertical slots cut in the sides. This is mounted on a slate base, and placed inside of a metal watertight junction-box, on the sides of which are small stuffing-boxes. To join two or more wires together, they are brought through the stuffing-boxes. The insulation is then removed, and the bare ends inserted through the slots and coiled up inside the junction pan. A soft tin washer is then laid on top of them, and a brass button is screwed hard up on them. As the diameter of the screw is very large compared with its length there is no fear of it coming loose, and the surface of wire used in the joint being large, there is no heating. A very good joint is thus obtained without the trouble and danger of carrying heated bolts or blow-lamps about. It is also much easier to disconnect portions of any circuit when searching for a fault which may have occurred. One of these boxes is used for each lamp, the stalk of the lamp being screwed through the cover of the box and forming the return, the current being carried to the lamp by an insulated metal rod in the centre, at the upper end of which is a spring contact which presses against the button of the junction. All joints in the small wires are made inside of junction-boxes, and there are no joints in the main cables. All the wires are of high insulation, the mains being Silvertown vulcanised rubber, lead-covered, and taped. Most of the small lamps are wired with vulcanised rubber-covered wire, made by the International Okonite Company, and the remainder, comprising the engine-room, stokehole, deck lights, etc., are wired with Fowler-Waring lead-covered armoured wire.

TELEPHONE TRANSMITTERS.

A short time ago, having occasion to call upon Mr. Lewis, the genial manager of the Western Counties and South Wales Telephone Company, we noticed a diagram indicating the various forms in which carbon has been used in transmitters. Mr. Lewis very kindly acceded to our request, and by his courtesy we are enabled to give the accompanying illustrations. Fig. 1 shows one of the well-known forms introduced by Prof. Hughes. and 2A show Edison's carbon button or disc, as in his transmitter, patented July, 1877, No. Fig. 3, also Edison's, shows lampblack of the best qu used in a transmitter. This was patented in July, 1877. Edison also uses finely-divided carbon, as does Hunnings, Fig. 4, patented September, 1878. In the Edison's, the divided carbon is between two discs; in the

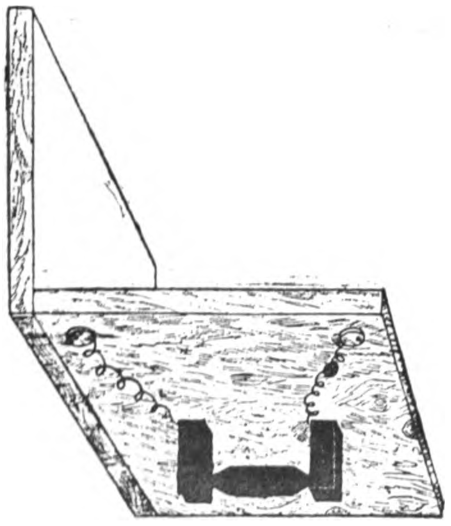


Fig. 1.

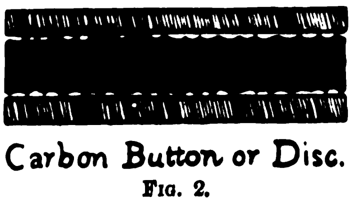


Fig. 2.

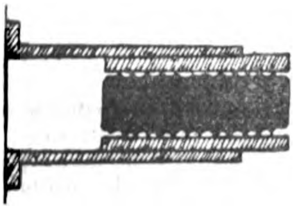


Fig. 2a.

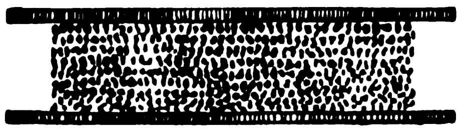


Fig. 3.

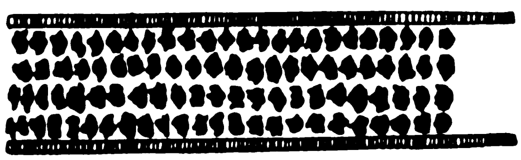


Fig. 4.

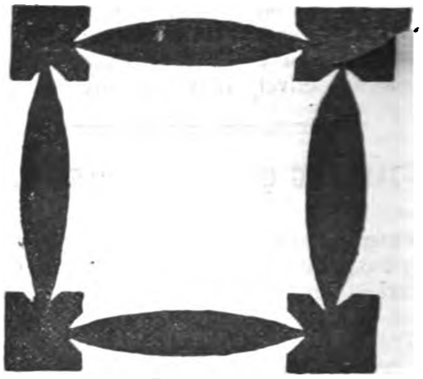


Fig. 5.

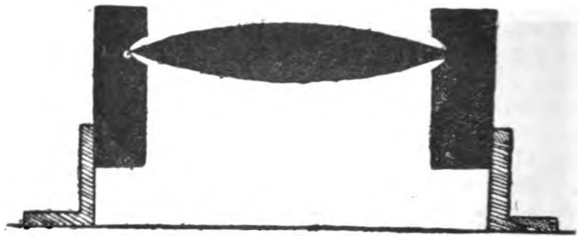
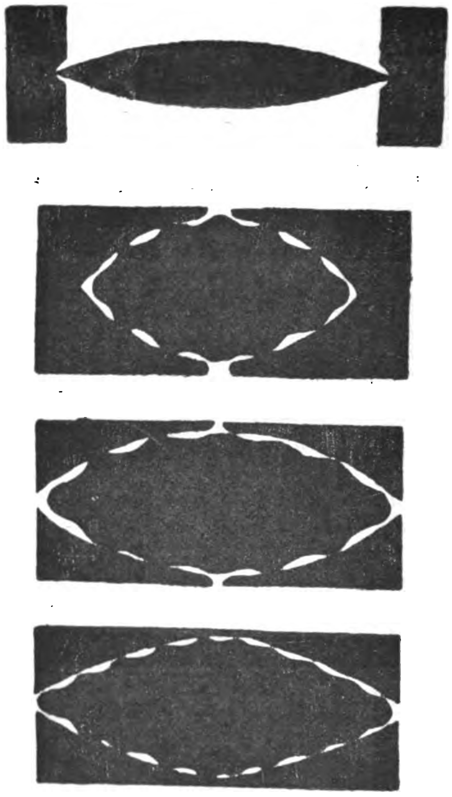


Fig. 6.



Figs. 7, 8, 9, and 10.

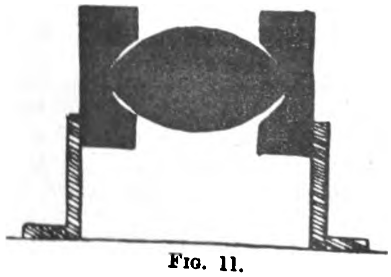


Fig. 11.

imensions of the magnet coils as 12·75in. diameter, the length as 0·5in., then they had

$$\text{Cdeg.} = \frac{1{,}017 \times 55}{840} = 60\text{deg.};$$

nd this added to the temperature of the engine-room, which might easonably be taken as 20deg., would bring up the temperature to omething like 87deg. C., a condition not at all favourable to a long ife for any machine. If, however, they applied the same test to the ynamos called Nos. 1 and 3, a reasonable voltage for charging 58 ells would be 140 at the terminals of the dynamo. The resistance eing taken at 11·5, then they found that

$$\text{Cdeg.} = \frac{1{,}711 \times 55}{840} = 112\text{deg.}$$

He was very pleased to see, from the remarks made by the author, hat there was a likelihood of his being able to add to the paper the whole particulars of tests; and he felt sure that this would make the paper of considerable value.

Mr. W. B. Sayers said the title of the paper would lead one to expect a fairly comprehensive treatment of the subject of lighting of public buildings by electricity, but unfortunately this was by no means found to be the case. Notably there was nothing in the paper about the way in which the wiring of the building should be carried out, or information as to how it had been done in the case of the Athenæum. He had taken advantage of Prof. Jamieson's offer, and had viewed the Athenæum installation; and he should like to ask Prof. Jamieson to state whether the information that there were no fuses employed except in the switches and ceiling roses, and in the mains at the switchboard, was correct? If this were so, a considerable length of the branch wire must in each case be unprotected by any except the main fuses, which were far too heavy to break before a branch wire became dangerously overheated in case of a short-circuit—a state of things which no fire insurance inspector up to his duty would or indeed ought to pass. Everyone who had had to do with the lighting of large spaces by means of incandescent lamps, would agree with the author of the paper as to the excellence of the Sunbeam lamps for this purpose. The space covered in by the Caledonian Railway bridge in Argyle-street was a good example of this. It was lighted by nine 200-c.p. Sunbeam lamps—the lamps forming part of the large installation which had just been completed by Messrs. Mavor and Coulson in the Caledonian Central Station and Hotel, which were now lit throughout by electricity. As Mr. Mavor dealt with Prof. Jamieson's statement that it was necessary to increase the pressure as the lamps got older, he would only point out two obvious ways of dealing with old lamps, and those adopted at the Central Station, which were (1) to move the old lamps into lavatories and places where small light was sufficient, and (2) to move them to places nearer the dynamo or source of supply, as there would generally be three or four volts difference of pressure between the two ends of the distributing cables and wires. The fact that he found triple expansion Westinghouse engines in use at the Athenæum, and that, while no mention of these was made in the paper, a compound Westinghouse engine was illustrated on the sheet, led him to enquire whether the table given in the paper showed the results of actual tests with the triple expansion engines, or forecasts of the expected results when these had been replaced by compound engines, which he understood was in contemplation. Prof. Jamieson, in his reply, stated that the tables were the results of actual tests, which statement he (Mr. Sayers) of course accepted; but it would be interesting to hear the explanation of the discrepancy between what actually existed and the illustrations in the paper in the matter of the engines. It would be a distinct advantage to run up a light partition to divide the engines and dynamos and switchboard from the boilers, in spite of Prof. Jamieson's arguments in favour of having them all in one compartment. This view, which he took from first seeing the paper, was emphasised when, on looking at the switches, and thinking they were somewhat light for the current they were said to carry, he ventured to touch the contact of one of them, and got his finger burned for his pains, although the current passing at the time was only 80 amperes, the switches being supposed to be capable of carrying 200 amperes. This heating was due partly no doubt to the switches being light, but also to their having the contact spoilt by the fine dust and grit which covered everything.

Prof. Jamieson said that as the time was so late (10.15 p.m.) he would answer the various speakers in writing. He was glad that so many points had been touched upon in the discussion, and he would endeavour to combat the different objections that had been raised to his views as expressed in the paper.

The **President** said he thought it must be apparent to everyone that Prof. Jamieson had, according to his light, devoted a great deal of attention to this subject in a thoroughgoing manner, and he had spent a great deal of time over it; and, therefore, the least they could do was to accord him a very hearty vote of thanks.

The vote was heartily accorded.

Prof. Jamieson sent the following reply in writing: Referring to Mr. Thom's remarks regarding high *versus* slow speed engines, the author was well aware of the increased economy derivable from working with a high piston speed. He had tested many engines of different kinds for the consumpt of steam per indicated horse-power and per boiler horse-power. In fact, it was only a day or so before that he had occasion to test a novel kind of rotary steam engine invented by Mr. Brown, of Swindridgemuir, Dalry, Ayrshire, which engine gave a consumpt of 47·5lb. of steam per boiler horse-power hour when run at 274 revolutions per minute, but over a continuous five hours' trial the consumpt was reduced to 37·9lb. steam per boiler horse-power hour when run at a mean speed of 574·5 revolutions per minute. This worked out about 27lb. per indicated horse-power from the indicator cards, taken with M'Innes indicator. The cylinder of this little rotary engine measured only 10½in. diameter by 8⅜in. deep, of which nearly one-half of the volume of the cylinder was occupied by the revolving piston, and it developed a mean of 20·78 boiler horse-power, with steam of 80lb. pressure per square inch in the cylinder.

The author was, however, glad to see that Mr. M'Whirter agreed with him in regard to the advisableness of employing, under certain circumstances, engines with a fairly long stroke, and fewer revolutions per minute, than those with a great number of revolutions per minute. It was not altogether a case of steam economy that the electrical engineer had to consider, for he had to take all these circumstances into account when ordering engines, and to weigh carefully how the total expenses would stand at the end of, say, one, two, or more years.

Mr. M'Whirter, near the commencement of his remarks, referred him to the discussion which took place at the Institution of Electrical Engineers on Prof. Forbes's paper (not last year, as stated by Mr. M'Whirter, but March 14th, 1889) on "Some Electric Lighting Central Stations and their Lessons" for the consumpt of steam by Willans's engines. He had looked up the *Proceedings* of that Institution, and found that Willans's engines were not referred to there in this light; but Mr. Robinson, the partner of Mr. Willans, said (at p. 229, *Proc.* Inst.E.E.), in reference to Prof. Forbes's hearsay statements regarding a 400-h.p. compound Corliss condensing engine in the central station at Berlin, using only 15·5lb. of water evaporator per electrical horse-power hour: "One cannot but wish for detailed figures of such tests as these, and for fuller particulars generally. Certainly we cannot match such figures as in England yet . . ." "I have seen an English condensing engine giving an indicated horse-power upon 15·1lb. of water." It was, therefore, quite evident that Mr. M'Whirter was mistaken. The author would feel much obliged for any reference to any authentic case wherein the consumpt of steam in any slow or fast speed non-condensing engine was less than 20lb. per hour per electrical horse-power, or 15lb. per indicated horse-power, since the double of those values were considered very good work. They must always take care, when speaking of the consumpt of steam per horse-power, that they knew exactly whether it was per indicated horse-power, or boiler horse-power, or electrical horse-power, for it made a very great difference to the results; also, whether the engine was a condensing or non-condensing one, or a simple compound or triple expansion engine.

Mr. Thom at the end of his remarks said, "It makes matters worse when you arrange the boiler to slide along the bottom." The boilers were not arranged as he supposed, but merely given freedom to cant over under the expansion of the steam dome. If the distance between the junctions of the boilers to the steam dome did expand ¼in., this would only mean $\frac{1}{32}$in. at the extreme ends of the two boiler seats, and here they had freedom to expand. Mr. Couper said: "In regard to the receiver which one gentleman had taken exception to, he might say that they did not approve of that either. They suggested a connection by a copper pipe, but Prof. Jamieson, as the consulting engineer, preferred a rigid connection, and went into the matter of expansion, to see how much expansion took place. . . ." This was not strictly true, for Messrs. Lindsay, Burnet, and Co., of which firm Mr. Couper was a partner, sent in their competitive tender, design and specification with rigid connections, without any suggestion or remarks *re* this point. Their tender was accepted, but before the firm began to make the boilers, he requested them to give him a design for a more flexible system of connections between the boiler and the steam dome. Their new design and extra price for this alteration was not accepted, for various reasons. The firm agreed to fit the connections with freedom faucet-joints, and to give further freedom from expansion in the different ways already mentioned. They thought, and all were agreed, that this would prove satisfactory, and as Mr. Couper remarked, "it had not given any trouble that he knew of."

To finish off the boiler question. Mr. Burnet, in his remarks, said, "One would have expected that a well-known public teacher like Mr. Jamieson would have treated this part of the subject in more exact language than to speak of horse-power of boilers without defining that horse-power in some way. The Athenæum boilers might be 60 of that unknown quantity, if you coaled them to that extent, but from Table IV. at that output, the heat efficiency was only 58·6 per cent." Mr. Burnet agreed in his tender to give them 60-h p. boilers, on the assumption that an indicated horse-power required 25lb. of steam per hour at 150lb. pressure. The Babcock-Wilcox Company always stated the power of their boilers as equivalent to 1 h.p. for every 30lb. of steam raised per hour at a certain pressure. He admitted the laxity of language used in this instance, more especially as the weight of steam (stated in Mr. Burnet's tender) per horse-power hour was lower than the general rule!

Mr. Burnet (as well as others) complained of the want of details in regard to the results given in Table IV. He should be only too glad to furnish these, but when they remembered how Mr. Burnet withdrew from the *Proceedings* of that institution the sectional drawings of the boilers and the feed-water heater, which his firm had given him liberty to make use of for the purpose of this paper; further, when they learnt that he had offered to place his whole services at his disposal for a twelve hours' trial of the boilers in question, and that he declined to accept the same, he could not but gather that he (Mr. Burnet) wished to keep matters quiet. However, since he and others had requested figures, he had, as they would observe, given full details of how the boiler efficiency was arrived at, and now supplemented these by the following Table V., which showed the main dimensions of the boilers, and by Table VI.,

NOTES.

Stock Exchange.—Telephonic communication is now open between the London and the Manchester Stock Exchange.

Price of Current.—At Saint-Brieuc the hecto watt-hour (100 watt-hour) is sold at ·7d. This is stated to be the lowest in France.

Bridlington.—New Local Board offices are to be built at Bridlington. It will probably mean a job for electrical engineers as well.

Translations.—The French Bibliothèque Nationale has opened a register of persons capable of translating scientific works into any tongue.

Electric Bus in Paris.—*Electricité* chronicles the appearance of a waggon drawn at considerable speed by electricity in the streets of Paris.

Overhead Wires.—At the London County Council mention was made that the London Overhead Wires Bill received Royal assent on 3rd inst.

Miners' Lamps.—The Renard chloro-chromic battery is being applied to miners' lamps, the weight being the same as the ordinary safety lamp.

Continental Electric Railways.—The Allgemeine Company of Berlin are to construct two electric tramway lines on the Sprague system at Stockholm and at Kiew.

Calcutta.—A new departure is to be made in street lighting at Calcutta. The Corporation are advertising for tenders for lighting the new Central-road with electricity.

Taunton Exhibition.—Field-Marshal Sir J. Lintorn Simmons has consented to open the electrical appliances and electric light exhibition to be held in Taunton shortly.

Accumulators for Sweden.—It is announced that the Swedish excise authorities have declared accumulators to be scientific instruments and allow them to enter duty free.

Electric Tricyles.—One of the most influential companies of Paris, says the *Bulletin de l'Electricité*, is experimenting with electric tricyles, and something further will probably soon be heard.

Chelsea.—The Vestry of Chelsea have presented a petition against the recommitment of the Electric Lighting Provisional Order Confirmation Bill, dealing with the parish of St. Luke, Chelsea.

Helston.—At a special meeting of the Town Council on Monday Mr. Veale, of St. Austell, gave details of the cost of lighting the town electrically. He is to give an estimate and confer with a committee on the matter.

Electrolytical Analysis.—The method of chemical analysis by electrolysis is spreading. A special installation of accumulators has been made, says the *Bulletin de l'Electricité*, for this purpose in the Ecole Normale Superieure of Paris.

Greenwich Observatory.—The Astronomer-Royal considers it desirable a complete installation of electric light should be adopted at the Royal Observatory. The lighting is now done by a number of Pitkin batteries and lamps.

City and Southwark Subway.—A long and interesting account of the English triumph in the electric subterranean railway to Stockwell has been given by the *Etoile Belge*, which is reproduced in *L'Ingenieur Conseil* for 12th July.

Telephones for Cardiff.—The Cardiff Town Council have resolved, on the motion of the chairman, that an estimate of the cost of establishing telephonic communication between the Bute Docks and the central police station be obtained.

Fribourg.—Water power is used at Fribourg for turbines driving dynamos direct for lighting and power. The current is distributed at the rate of ·1d. per horse-power hour over 20 h.p.; ·12d. from 5 h.p. to 20 h.p.; and ·15 for less than 5 h.p.

Richmond Town Hall.—Municipal buildings are to be erected at Richmond to designs by Mr. H. J. Ancell, architect, 3, Staple-inn, London. They should be wired ready for electric light. The tenders are to be sent in by August 4 to the town clerk, Richmond.

Paris.—The Creuzot Works have received the contract to install the electric light in the Gare d'Orleans at Paris. The Ganz system will be used. Sixty lamps of 25 to 40 carcels, and two of 250 carcels, are also being installed by another firm in the Gare Montparnasse.

Continental Telegraphs.—In the Lower House of the Austrian Diet, the Marquis von Bacquehem, Minister of Commerce, stated that there was a prospect of the establishment in the course of the year of a direct telegraph line connecting Vienna, Munich, Paris, and London.

Personal.—Mr. E. Manville, M.Inst.E.E., writing to us from Albany-buildings, 39, Victoria-street, Westminster, notifies us that he has severed his connection with manufacturing companies, and is now carrying on exclusively the profession of consulting electrical engineer at the above address.

"Journal."—The *Journal* of the Institution, part 94, has appeared, and contains Dr. Fleming's, Mr. Preece's, and Mr. Crompton's contributions to the science of electrical mains, with discussions thereon, with also classified list of articles on electrical subjects and abstracts from the foreign journals.

Glasgow.—As will be seen from their advertisement, the Glasgow Corporation are desirous of securing a competent electrical engineer. The situation is an important one, and the salary will commence at a minimum of £250 a year, the engineer's whole time and attention to be given.

Electrical Units.—At the ensuing British Association meeting at Cardiff, it is proposed to hold in Section A, if possible in conjunction with Section G, a discussion on "Units and their Nomenclature," having special regard to the new electrical and magnetic units now becoming necessary for practical purposes.

Society of Arts.—The council of the Society of Arts have been asked by the Government to undertake the duty of organising the British section at the Chicago Exhibition in 1893, and are to be constituted a Royal Commission for that purpose. The formal documents constituting the commission will be issued very shortly.

Obituary.—Dr. William Henry Stone, consulting physician to St. Thomas's Hospital, died last week at his residence, Geraldine-road, Wandsworth, in the 62nd year of his age. Dr. Stone was very well known in electrical circles from his attention to questions of electricity in physiological science, and especially to that of the electrical resistance of the human body.

Canterbury.—At the meeting of the Canterbury General Purposes Committee last week, the Mayor mentioned that the Dover Corporation intended inviting contracts from the different companies to take over the provisional order; they would thus see which company proposed that the fixing of the date be left to the town clerk, and said the Corporation should not allow the lighting of the city to be taken out of their hands again. The proposition was agreed to.

City Lighting.—The Streets Committee of the Commissioners of Sewers have reported that a notice had been received from the Brush Electrical Engineering Company of their intention to lay a line of main conductors under the footway of both the north and south sides of Cannon-street, from Walbrook to and including the south side of St. Paul's-churchyard, and a line of main conductors from Queen Victoria-street, through Bucklersbury to the junction-box by the Mansion House, and the committee recommended that consent should be given, subject to the provisional order, and that the committee be empowered to give the necessary sanction, from time to time, for the different sections of the work of City electric lighting, subject to the contracts and provisional orders.

The World's Fair.—It is probable that the Chicago Exposition will be open in the evenings, in all its departments. Plans and estimates have been invited for lighting by electricity all of the buildings. It is proposed to light both the buildings and grounds so brilliantly that everything can be seen at night as well as by day, and it is expected that the scene at night will be one of marvellous brilliancy. United States Attorney-General Miller has rendered a decision that will be of great interest to foreign exhibitors. It is to the effect that these exhibitors can bring with them enough employés to show the process of manufacturing the goods they display without being held for violation of the contract labour law. The decision was rendered at the request of the French Consul in Chicago, who represented that many manufacturers in France would not take part in the fair unless they could bring with them a limited number of employés. The Chicago Exhibition authorities have already received 1,000 applications for space.

Athletic Sports.—Mr. Ronald A. Scott, M.I.E.E., M.R.I., etc., the well-known electrical engineer, evidently vies with his brother, Commander Percy Scott, R.N., in getting up athletic meetings, and notwithstanding the counter attractions of the Royal review and the Eton and Harrow match, nearly 500 visitors responded to the invitation on Saturday last, and evidently thoroughly enjoyed themselves in the grounds, some 20 acres in extent, which surround Mr. Scott's residence, "The Elms," Acton-hill, W., so well known to travellers along the Uxbridge-road. There were 16 events, all well carried out; but the final one, walking the greasy pole over the lake, was certainly exciting and caused roars of laughter, whilst it brought out some splendid exhibitions of swimming. At last, after many futile attempts and consequent duckings, General Rich's son made a rush for it and succeeded in picking off the flag during his somewhat comical descent into the water. All the competitors were members of the Acton-hill Electric Engineering Works.

City Electric Lighting Company.—The new company for taking over the contracts and concessions for the electric lighting of the City has been brought out this week, under the name of the City of London Electric Lighting Company, Limited, with a capital of £800,000 in 40,000 preference and 40,000 ordinary shares of £10 each, of which the ordinary shares are now issued. The directors are Sir David Salomons, Bart., chairman, Edward Lucas, Esq. (of Messrs. Lucas, Micholls, and Co.), F. W. Reynolds, Esq. (of Messrs. F. W. Reynolds and Co.), the Duke of Marlborough (chairman of the Electric and General Investment Company, and of the Brush Electrical Enginering Company), the Earl of Suffolk and Berkshire, Hon. Alan Charteris (Lloyds, E.C.), J. Bevan Braithwaite, jun., Esq. (director of the Electric and General Investment Company, and of the Brush Electrical Engineering Company). Chief engineer, Major-General C. E. Webber, C.B., past-president of the Institution of Electrical Engineers. Secretary, J. Cecil Bull, Esq. Offices, 1 and 2, Great Winchester-street, E.C.

The German Emperor's Palace.—It will not be without interest at this juncture to read the details of the electric installation at the Royal Palace at Berlin. Hitherto the illumination has been by candles, no gas having been admitted. The whole has recently been fitted with electric light. The plant consists of two engines, of 150 h.p. and 50 h.p. Space is arranged for two others of 200 h.p. each. There are two dynamos—a four-pole machine driven by the smaller engine, and a six pole machine of 100,000 watts, coupled to the 150-h.p. engine. When finished, the total present capacity will be 360,000 watts, with a battery of 860 ampere-hours capacity. In the Imperial chambers there are 557 lamps of 10 c.p. to 25 c.p. The corridors contain 152 incandescent lamps, and offices 133 lamps. The gateways have nine arc lamps of six amperes. The ball-rooms and drawing-rooms have in all 1,960 incandescent lamps, of which over 1,000 are in the great White-room. A number of motors are also used. It is expected that two other Siemens dynamos will be installed with a further battery of 800 ampere-hours.

Telephone Clauses in the Electric Lighting Acts.—At a recent meeting of the Electric Trade Section of the London Chamber of Commerce, the secretary of the Chamber stated that they had approached the Board of Trade on the question of telephone clauses in the Electric Lighting Acts, but the reply was considered so unsatisfactory that the idea of sending an influential deputation was abandoned. We learn now, that although it was not communicated to the secretary of the Chamber, that the Board of Trade had evidently thought better of it, and subsequently altered the provisional orders by inserting those clauses for the protection of the telephone company desired by the Chamber of Commerce, in lieu of those previously inserted in the orders. It is believed that the action of the Chamber has in no small degree contributed to the satisfactory result, and we would hope that the same body may now be able to achieve an equally satisfactory result in regard to the "overhead wires" question; action in regard to which we believe was only delayed in consequence of the unsatisfactory reply already referred to.

Tenders for Bradford Town Hall.—The Finance Committee of the Bradford Town Council have recommended that the Council should accept the tender of Mr. Wilson Hartnell for the providing and fixing of fittings required in the lighting by electricity of rooms in the municipal buildings, for the sum of £630. Mr. James Pratt asked why it was that the committee had not advertised for tenders, and why, if they thought it expedient to advertise, they had not seen their way to let the contract to a Bradford firm. Mr. S. Robinson suggested that the question should be allowed to remain over. Alderman F. Priestman said that he believed the course taken by the committee was to select six or eight firms who were thought suitable, and invite them to tender for the work to be done. The tenders in the present instance were in the room, and the committee, after going carefully over the matter, accepted the lowest one. Mr. Oddy accepted the suggestion made by Mr. Robinson as to allowing the resolution in reference to the electric lighting of the Town Hall to stand over for the present. This part of the resolution was therefore withdrawn.

leave of absence, and that he be granted the sum of £100. In moving that the recommendation be confirmed, Alderman Bromley said that Mr. Lobley had undertaken a great deal of work for the Corporation outside the strict duties of his office, and had thus saved the town a considerable sum in extras and architects' fees. He had well earned the gratuity of £100 which it was proposed to give him. Mr. Shirley seconded the motion, mentioning that Mr. Lobley proposed visiting America during his holiday, mainly with the object of enquiring into the question of lighting towns in that country by electricity. Alderman Charlesworth, in supporting the motion, said the borough was to be congratulated upon having in Mr. Lobley not only an efficient borough engineer, but a man of architectural skill. His extra services as an architect, not only in connection with the Town Hall, Victoria Hall, and Sessions Court, but at the Shambles and other Corporation property, had saved the town, it was estimated, at least £500 or £600. An amendment to the effect that the leave of absence be granted, but not the gratuity, having been proposed, the Mayor pointed out that the Corporation were committed to the expenditure within the next few years of £30,000 or £40,000 in electric lighting, and upon that question they required the fullest information. In America electricity for public lighting was more largely used than in this country, and as the surveyor was going to enquire into the subject during his holiday, he thought the Council would get their money's worth back again in the information and assistance he would be able to afford them. After a long discussion, the amendment was rejected, and the recommendation of the committee was then confirmed.

Withdrawal of the Birmingham Tramways Order.—The Central Tramways Company have, it is understood, abandoned the provisional order they were promoting in Parliament to authorise the extension of the electric tram line in Birmingham. This action has been forced upon the company by the opposition of the telephone company, which obtained from the Lords' Committee a clause requiring the tramway company to protect the underground telephones by making provision for return currents wherever electric tramway cables may be laid. The cost of such an arrangement, according to the tramway company's witnesses, would amount to £1,500 per mile, and the total cost, supposing electricity to be adopted throughout the tramway system, is estimated at £20,000. The directors felt that they could not ask their shareholders to submit to a requirement, in their judgment, so excessive and unjust, and therefore, rather than accept the clause, they have withdrawn their order. The immediate effect of the telephone company's opposition is that the Bristol-road electric trams must still stop in Suffolk-street to the great inconvenience of passengers, although the Navigation-street lines are laid and were used for a time, until it was found necessary to obtain further powers to legalise their use. The further and more serious effect is that the development of the electric system of traction is rendered impossible, because the cost of laying underground wires (the only method that will pay) is rendered too heavy through the demand of the telephone company. The application of the tram way company, it will be remembered, was strongly supported by the Corporation, and they resisted the claim of the telephone company. The success of the latter company, and the consequent necessary withdrawal of the tramway company's order, compels Birmingham to submit for an indefinite period to the nuisance of steam trams, which would otherwise have been replaced by electric trams. This result is greatly to be regretted. It is hoped that on a future application, made before another Parliamentary Committee, the tramway company may be successful in obtaining its order without the intrusion of the obnoxious clause.

Bradford Central Station.—Before the Bradford Town Council, on Tuesday, Alderman F. Priestman stated with regard to the electric lighting works, the present works had cost £35,000, and he was going to ask for £5,000 or £6,000 for increasing those works. It was proposed to put down one 300-h.p. engine, and two 80-h.p. engines. The works now were able to supply 3,500 amperes, and with this addition would produce 1,800 more. The proposal to light the Town Hall was before the Council, and would probably soon be carried out, and the committee had a large number of demands for the electric light current. They had not pressed the matter, for they had the interests of the gas works—in which a large amount of capital had been sunk—to preserve, but the increased demand was consequent upon the superiority of the electric light. He apprehended that the Council would wish that the committee should keep pace with these demands. The two smaller engines were required to obviate the necessity of running the larger engine in the morning, when the demand was at its minimum. By this means the very uneconomical proceeding of running a large engine at a low power was rendered unnecessary. Mr. Galloway objected to additional expenditure until the station paid. Mr. Alderman Feather objected to the expense of maintenance. He understood that they were at present consuming 6lb. of coal per hour for each indicated horse-power, which he had been informed could be reduced to 1½lb. per hour. He was further given to understand that a proposal had been made to the Halifax Corporation to supply a complete electric plant and guarantee a net profit of 7½ per cent.; and if that could be done at Halifax, it could be done at Bradford. Alderman Priestman, in reply to Mr. Galloway, said he considered the proposed expenditure on the electric light station a wise expenditure. Up to the 31st of December, 1889, the loss on the electric lighting works was £1,079; during the half-year ended the 30th of June, 1890, the loss was £732; and from that date to the 30th of December, 1890, the loss was £315. That showed clearly that they were now on the verge of making the works pay, and from the facts and figures he had given to the Council he had not the slightest hesitation in saying that by the end of next year those works would be paying more than the interest on the money expended on them. Alderman Feather's statement as to the consumption of coal was not correct. The quantity of coal consumed depended on the quality of the coal used, and instead of the consumption reaching 6lb. per hour, it was more nearly about 2½lb. to 2¾lb. per hour. At certain periods, when only a very slight load was upon the engines, the consumption might be 6lb. per hour per horse-power, and that was the reason why he was asking for two small engines. He appealed to the Council to complete the installation in the way proposed by the committee. He believed that it would very soon be the duty of someone to ask the Council to spend an additional sum of money on the electric light works, and that would be the best time to deal with the question of economy of fuel. He thought the committee was proceeding in the most economical course possible. There had been a complaint in some quarters about the committee not adopting the alternating current, and in answer to that complaint he wished to state that the direct and continuous current was the one most favoured by authorities on the subject, and was the one which would probably be generally adopted in the future. The resolution was carried.

all joints underground, and with a view to facilitate this operation, they have devised a portable vulcanising kit, and drawn up a set of instructions for the proper making of these joints.

Although too long to give in full, a brief *résumé* of these instructions may be of interest, together with a description of the special "cure" employed. This latter consists of a cast-iron T-shaped box made in halves, with flanges so that they can be bolted together. Three circular openings are provided, one at each end of the box, and one at the end of the T-piece, for the introduction of the cables to be jointed, and an opening is provided in the top half for pouring in molten sulphur, and a cock on the bottom half for drawing it off at the end of the cure. The joint between the two halves of the box is made with asbestos packing, and those at the places where the cables enter, by wrapping the cable with a strip of common rubber. The sulphur is melted in a separate pot, and when all is ready is poured into the cure, the temperature being maintained by placing one or more spirit lamps under the cure, and observed by a thermometer introduced into the sulphur through the hole in the top of the box. With regard to the actual making of the joint, the following method is recommended: The copper joint is carefully soldered with resin as a flux and finished smooth and clean. The ends of the rubber, which have been exposed during the making of the copper joint, are then pared down to as long a taper as can be made, and the conductor is lapped tightly with one or more layers of pure rubber strip, which extend partly over the tapered surface of the original insulation. One or more layers of vulcanising rubber are then put on over the full length of the joint, care being taken to lap them so as to exclude air. The joint then made is tightly bound up with prepared tape, is then covered with a piece of sheeting, making a longitudinal seam, and firmly bound over all with selvedge tape. The sheeting and selvedge tape act as a mould to keep the joint in shape during the vulcanising process, and are removed again when this is completed. The two halves of the cure are then placed around the joint and are bolted together, the joints being made tight in the manner described above. Molten sulphur is poured in, and is maintained at a temperature of about 290deg. to 300deg. F. for half an hour, by which time the cure is complete; the sulphur is then drawn off, the cover removed, and the wrappings taken off the joint. If the rubber is properly cured, it should, when cold, be springy and yield to the pressure of the thumbnail, but no mark should be left when the pressure is removed. The joint is then finished by covering it with prepared tape as a mechanical protection.

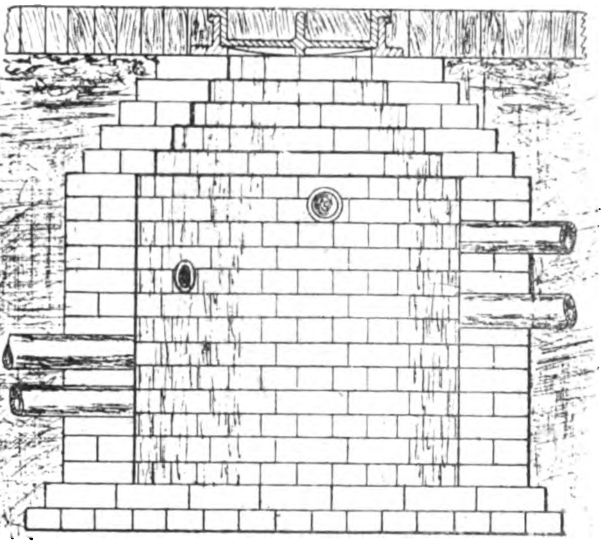


FIG. 2.—Brick Manhole. Silvertown System.

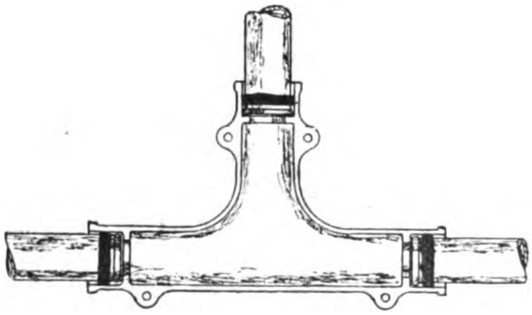


FIG. 3.—Branch Junction. Silvertown System.

The importance of good jointing is a matter which the Silvertown Company specially insists on, and it certainly seems rational that when a continuously insulated cable is employed no uninsulated conductor surface should be allowed underground. A system of separate short lengths of insulated cables into each house, such as adopted by Mr. Bailey for the Metropolitan Company, offers, however, very great advantages in the matter of testing, and facilitates the withdrawing and replacing of cables, and we understand that the Silvertown Company fully appreciates the advantage of such a system, where the connections can be made at the primary fuse-boxes in the householder's cellar, and where proper precautions are taken to prevent excessive surface leakages.

The Silvertown Company claims that it has an excellent record for underground work, as wherever their cables have been used and laid in accordance with their recommendations, the result has been eminently satisfactory. The amount of work done by them may be judged by the list we give below of the supply companies in Great Britain who are employing their cables, in addition to which they have also laid them for a large number of private installations, amongst them the lighting of their own factory, where rubber cables have been in use in concrete trenches for about eight years. On the Continent also the high-tension distribution in Paris, Tours, Madrid, and Barcelona is almost exclusively carried out with their cables, made either at Silvertown or Persan, and large quantities have been shipped to India, Australia, and South America for local supply companies:

London Electric Supply Corporation; Westminster Electric Supply Company; Metropolitan Electric Supply Company; House-to-House Electric Supply Company, West Brompton; Brighton and Hove Electric Supply Company; Crompton and Co., Chelmsford; Eastbourne Electric Supply Company; Muir, Mavor, and Coulson, Glasgow; Hastings and St. Leonards Electric Company; Newcastle-on-Tyne and District Electric Light Company; and Woking Electric Light Company.

CREOSOTING TIMBER.*

BY E. J. SILCOCK, A.M.I.C.E., F.G.S., BOROUGH ENGINEER, KING'S LYNN.

In bringing the subject of creosoting timber before this association it is hardly hoped that any new matter will be introduced. The whole subject has been most fully discussed by Mr. S. B. Boulton, A.I.C.E., in his paper on "The Antiseptic Treatment of Timber," read before the Institution of Civil Engineers, and the author acknowledges the great assistance which that paper has been in the preparation of the present communication. Although the subject has been so fully dealt with, the author finds no generally accepted practice, and having had some little experience of the work, hopes by means of this paper and a fresh discussion to ensure a greater uniformity in the specifications issued by the members of the association. There is at present such a variety in the requirements of different specifications that it is practically impossible to comply with all with the same plant. The result of this no doubt very largely is, that when firms are putting down creosoting plant they only provide for the requirements of the majority of their customers. Now, unfortunately, this majority is usually that section which is somewhat lax, and contractors take alike all orders with the hope that they may be able to get their work passed even in cases where their plant cannot carry out the specification. At present a good specification and thorough inspection are met with the declaration that submits, is impracticable, as from several analyses of commercial creosote he finds that the residue at 600deg. varies from 8 to 15 per cent. Probably 25 per cent. over 535deg. F. is about as much as is obtained in practice. At the same time the oil should be completely liquid at a temperature of 100deg. F., or it cannot be injected sufficiently freely into the fibre to form the skin or shell before referred to. No ammoniacal water should be present in the creosote, as it has an injurious effect upon the timber. It is the practice of some firms to mix crude tar with their creosote oils, especially if they use country oils. This course should be deprecated, as the crude tar contains all the oils lighter than water, which are of no value for creosoting purposes, and also a large quantity of pitch, the carbon in which prevents the oil from penetrating the fibres of the timber. Occasionally bone oils and mineral oils are used for creosoting purposes, but as they contain no antiseptics they are unfit for the purpose, and should be rejected.

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* Paper read before the London meeting of the Association of Municipal and County Engineers.

In America creosote proper—*i.e.*, oils obtained from the distillation of wood—are largely employed. This, no doubt, arises from the fact that timber is much cheaper in America than in this country, whereas coal is much more expensive. Wood creosote is much more uniform in its constituents than coal-tar creosote, and is less volatile and soluble when exposed to air and water; it also contains no ammonia, which is considered to hasten decay. It is said to be much more effective in protecting timber from marine insects than coal-tar creosote. The quantity of oil to be injected varies in most specifications from 6lb. per cubic foot to 12lb. per cubic foot. Generally, it may be said that the more creosote is injected, the more efficient the process; but, of course, when this principle is carried to excess the expense becomes prohibitive, and it is found that, except in the case of very young timber or very small scantlings, 12lb. per cubic foot is about the practical limit The author has, however, seen Baltic sleepers, 10in. by 5in., which absorbed over 20lb. per cubic foot, so that although for large scantlings it may not be possible to inject such a large quantity as this, still there is no practical difficulty in getting 10lb. to 12lb. injected into any timber of the coniferous class. The specific gravity of creosote being about 1·05, a gallon weighs 10½lb., and the author submits as a standard that one gallon per cubic foot should be required, as it is more convenient to measure the quantity in gallons than in pounds. The processes by which creosote is injected into timber in this country are four in number—viz., the open tank process, Bethell's process, Boulton's process, and Blythe's process. These will now be described in the order named. Of the open tank process very little need be said; it consists merely of steeping the timber in creosote in an open tank. Unless the process is carried on for a very lengthened period, say, several weeks, and the oil is kept at a high temperature, it does not penetrate beyond a very short distance from the surface of the timber, unless there is a large proportion of sap wood, or the scantlings are very thin. A few shavings with a plane will entirely remove all traces of creosote from the heart wood. This process, therefore, cannot be said to be very satisfactory.

In Bethell's process the timber is placed in closed iron cylinders, varying in length from 40ft. to 80ft., and in diameter from 4ft. to 7ft. The cylinders have hemispherical ends, one of which is loose and is suspended from an iron arm fixed to the cylinder, so that during charging and discharging it can be swung on one side. The cylinder is provided with a faced flange at the end which opens, and the hemispherical end is secured in its place by screw-clamps which clamp the end to the cylinder flange. The creosote is contained in a tank or tanks underneath, or to one side of the cylinder, and the tank and cylinder are connected by an iron pipe led from the bottom of the cylinder, and provided with a stop valve. Hot-water or steam pipes are taken from a suitable boiler and furnace into the creosote tanks, so that the temperature of the oil can be raised to 150deg. F. before admission to the cylinder. An air pump and a pressure pump, driven either by steam or hydraulic power, are placed in a shed adjoining the cylinder; the air pump being connected to the creosote cylinder by suitable piping, and the pressure pump drawing its supply of creosote from a tank and discharging it into the creosote cylinder. It is preferable, if possible, to have a separate tank for the pressure pump to draw from, as the quantity of creosote injected can then be more accurately measured. The process is then carried out as follows: The timber is placed in the cylinder, the hemispherical end fixed, and the air pump is set to work to exhaust the air from the space unoccupied by the timber and from the pores of the timber, the valve between the cylinder and the creosote tank being closed and a vacuum of about 10lb. per inch being maintained. At the end of an hour the valve is opened, and the atmospheric pressure causes the creosote to rise up the pipe connecting the cylinder and tank, and fills up all spaces in the cylinder not occupied by timber. When the tank is full the air pump is stopped and the pressure pump is set to work, and creosote is pumped in under pressure until the required quantity has been injected into the wood. The time occupied in this operation depends on the quantity to be injected and the state of the timber, varying from 10 minutes to as many hours, the pressure varying from 30lb. per square inch up to 120lb. per square inch. The quantity to be pumped is determined by multiplying the cubical contents in feet of the charge of timber by the specified quantity of creosote per cubic foot. The tank from which the pressure pump draws its supply is provided with a gauge by means of which the quantity pumped can be measured. When the required quantity of creosote has been injected the pump is stopped, and the valve connecting the cylinder with the creosote tank is opened, and the oil is allowed to drain back into the tank. The cylinder is then opened and the charge of timber withdrawn.

Boulton's process differs from Bethell's in that the temperature to which the oils are raised in the creosote cylinder is 212deg. F. to 220deg. F., instead of 120deg. F. To effect this, steam-pipes are introduced into the creosote cylinder. The plant required is similar to that for Bethell's process, except that besides the above-mentioned steam-pipes, a steam-dome is fitted to the cylinder, and a surface condenser to the air pump. The principle on which the process rests is the fact that whereas the boiling points of the creosote oils vary from about 250deg. F., to 700deg. F., that of water is 212deg. F., consequently all the moisture present in the timber is driven out in the form of steam by the heat of the oils, and this steam is exhausted by the air pump and subsequently condensed without any appreciable quantity of creosote being evaporated. At the same time the timber does not suffer from this excessive heat, because that heat is applied through the medium of the oils, and is not a dry heat. The process is carried out in the following manner: As soon as the cylinder is charged with timber and closed, oil is introduced until the cylinder is nearly full, and the temperature raised to 212deg. F. to 220deg. F. The air pump is then started, and the air and steam exhausted until no further water flows from the condenser. The pressure pump is then worked until the required quantity of creosote is injected. The timber absorbs a large quantity of oils by displacement as the moisture is driven out, so that the pressure pumps have less work to perform, and less oil has to be forced in by that means—a clear advantage over Bethell's process. The total quantity of oils injected is the sum of the quantity absorbed by displacement and the quantity injected under pressure. The first of these quantities is ascertained by completely filling the creosote cylinder and dome with oil before the air pump is started, then reading the gauge in the creosote tank. A small quantity of oil is then run back from the cylinder into the tank, to secure a space at the top of the cylinder in which the air and steam can gather. When the exhausting process is finished, the cylinder and dome are again filled and the gauge again read. The difference between the two readings gives the quantity required—*i.e.*, already absorbed. The second of these quantities is the balance required to comply with the specification, and this is then pumped in by the pressure pump from a tank fitted with a contents gauge. Boulton's process is a very marked improvement on the older system, more especially when treating timber which has been water-seasoned, or which is very green. To put it in plain words, the timber is boiled in the creosote, and by that means all the water and most of the sap are removed, as well as variable, the battery must be at once charged to its full capacity, in order to furnish any lighting that may be necessary. With another arrangement the dynamos might have been run all the morning, which would be a good deal cheaper than the use of the batteries, and the battery need only be charged sufficiently for ordinary requirements.

Financial Statistics.—The following are the figures given in the report of the cost of construction:

Central Station.	Marks.
Steam engines	51,750·10
Dynamos	49,887·17
Accumulators	22,309·66
Movable cranes	2,706·42
Boilers	39,908·25
Instruments and apparatus	39,968·44
Total (marks)	206,530·04
Mains.	
Cost of conductors	199,920·63
Laying	10,912·46
Junction-boxes	6,440·93
Total (marks)	217,274·02
Buildings.	
Cost of sites	50,055·35
Generating station	62,026·94
Heating by steam	976·83
Front of building	40,470·93
Accessories	4,970·37
Total (marks)	158,500·42
Management and General Expenditure.	
Management of works	31,390·97
General expenditure	9,569·31
Total (marks)	40,960·28
Incidental Expenses.	
Cost of installations at customers	36,806·53
Telephone	84·71
Total (marks)	36,891·25
Summary.	
According to the figures above the cost of construction amount to	660,156·01
From this are reimbursements for installations carried out	43,522·24
Leaving (marks)	616,633·77

The customers have to pay the necessary charges for laying the current on to the house, for the running of all wires inside the entrance of the house, as well as all necessary fittings. For the meters, which are lent by the town, 5 per cent. of their value is to be paid as hire. The normal price of one 16 candle-power hour is four pfennig, equal to just under ½d. The charges for incandescent lamps of higher candle-power, and of arc lamps, are either reckoned proportionately to the consumption of current or the candle-power.

After the station had been put into operation it was decided, besides this, that the customer must pay for all arc carbons used as well as for the cost of these lamps themselves, while the incandescent lamps were to be supplied and renewed by the town. Against this the Municipality levied an annual tax of six marks per incandescent lamp of 10 c.p. to 50 c.p., and of 25 marks per arc lamp. These conditions were not approved by the customers, and were afterwards modified (1st September, 1889), enacting that the customers must procure not only the arc lamps and their carbons, but also the incandescent lamps, or rather buy them at the electric station, the tax for lamps being altogether suppressed. At the same time a minimum period of lighting was enacted, corresponding for a 16-c.p. lamp in private houses to 0·6 of an hour a day, and in shops and factories to one hour a day. The other incandescent lamps, and the arc lamps, have proportionate minimum periods. The subscriber who has not paid for the full minimum is charged the difference at the end of the year. On the other hand, the following rebates are given, taking the 16 c.p. as basis.

Hours of service.	Rebate.
800 hours a year per lamp	5 per cent.
1,000 " "	7½ "
1,200 " "	10 "
1,500 " "	12½ "
2,000 " "	15 "

From the table of the "active" and "passive" capital in the electric light station on April 1, 1890, as well as the statement of receipts and expenditure of the 16 candle-power hour taken as basis, it appears as if the Municipality would have to subscribe yet further to the cost of maintenance before the installation is on a paying basis.

Statement of Accounts, April 1, 1890.

1. ACTIVE.

	Marks.
Engines, boilers, dynamos, cranes, apparatus, and instruments	189,388
Accumulators	22,734
Installation material	5,208
Mains	243,753
Buildings	164,688·93
Provision of reserve material, installation stores, warming apparatus, etc.	11,379·86
Total (marks)	637,151·79

2. PASSIVE.

Capital: Loan July 1, 1888, at 3½ per cent., 627,500, less sum deducted for 1888-9, 3,137·50	624,362·50
Loan at 4 per cent. from Municipality, subvention for extraordinary expenditure	1,409·43
Funds for maintenance provisionally put at the disposal of the electric light fund	11,379·86
Total (marks)	637,151·79

Statement of Receipts and Expenditure, 1889-90, *including Accessories Revenue.*

1. RECEIPTS.	Marks.
Sale of current	55,822·84
Lamp tax	6,907·81
Hire of meters	837·53
Sale of arc lamps and carbons	539·74
Rent received for buildings and sites	900·00
Various receipts	226·26
Charge for house installations	2,513·56
Total receipts (marks)	67,747·74

2. EXPENDITURE.	Marks.
Interest on capital	21,907·50
Sinking sum on loans	3,137·50
Salaries and wages	17,284·09
Office expenses	929·27
Commissions	45·48
Taxes and contributions	1,005·15
Maintenance of buildings, etc.	337·90
Maintenance of machinery	839·15
Consumption of fuel and water	11,674·45
Cleaning material and oil	1,432·42
Lighting of station	1,509·11
Maintenance of underground mains	14·53
Manufacture and maintenance of meters	1,013·79
Manufacture of incandescent lamps	8,323·86
Manufacture of arc lamps, etc.	454·67
Maintenance of instruments and tools	162·37
Cost of house installations	2,130·12
Renewal funds	12,472·11
Total expenditure (marks)	84,073·47

The hour of service for one 16-c.p. incandescent lamp costs four pfennig, or ½d., so that for a sale of current of M. 55,822·84, the number of lamp-hours is 1,395,571.

It results, from above, that the cost price per 16 c.p. lamp-hour at the customer, deducting the accessory receipts, is:

$$\frac{84{,}073{\cdot}47 - 11{,}924{\cdot}90}{1{,}395{,}571} = 5{\cdot}1069 \text{ pfennig, or about } 0{\cdot}6\text{d.}$$

THE

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CARLOW.

The recent election at Carlow has made prominent at the present moment a town which seems destined to become still more prominent, being the first Irish town to recognise and act upon the conclusion that the waste water power near a town might with advantage be utilised to provide light. The ordinary Englishman, used to the high pressure of business life, can hardly realise the exact position of such towns as Carlow in the ranks of progressive towns. To him, accustomed as he is to noise and bustle, the quietude of a prosperous, comfortable county town in the midst of a purely agricultural country is characteristic of Rip van Winkleism rather than of progress. But, on the other hand, those who live in remoter districts claim to recognise the go-aheadness of such places as Carlow. From whatever standpoint one views the situation, the fact remains that Carlow, for good or for ill, has taken a step which other places have talked about, and done, when the talk has ended, absolutely nothing. Situated some 56 miles south of Dublin, at the junction of the Burren with the Barrow, a considerable amount of water power is available. In years gone by, before Russia, America, and remoter parts of the earth supplied us with corn and flour, huge mills were actuated by the waters of the Barrow, and many another Irish stream. Now the mills are not worked. More modern milling appliances, added to the action of the Corn Laws, have driven the industry into other quarters. At Milford, some five miles from Carlow, stands one of these some time silent mills, its huge waterwheel inactive, and its gearing rusting away. The happy thought of using the waste power came to willing ears, and the result has been to install in a portion of the old mill, a dynamo-room, the machinery in which is at present driven by the old mill wheel, but which will soon be driven by turbines. With a little care we should imagine some three hundred horse-power can be obtained from the Barrow at this point, and two-thirds of that power would suffice to light every nook and corner of Carlow. The matter of the town lighting had long been a sore point. The Commissioners and the gas company did not quite agree, and latterly the town was lighted with oil—when the question was put to Mr. J. E. H. Gordon, who grasped the situation, made his proposal to the Commissioners, which was accepted, and within a few months of such agreement the work has been so far completed that the town lighting is regularly carried out. The formal inauguration of the lighting was, as is usual in such cases, made the pretext for a convivial meeting and dinner at the Town Hall on Monday last. Mr. Hammond, the newly-elected member of Parliament for Carlow, who has for 12 years been chairman of the Town Commissioners, delayed taking his seat in the House of Commons in order to be present at the inaugural banquet. This action tells its own tale as to the interest taken in the lighting. Deputations from Derry, Kilkenny, Portadown, and other places were also present to inspect the works and the results at Carlow, and from what we could gather it is pretty certain that a number of towns will follow the lead given to them. It seems to us, then, that a good meed of praise should be given to everyone connected with this lighting. Certainly Waterford, Belfast, and other places in Ireland have not been behindhand in introducing the light, but here we have an inland town of only some six thousands of population, with no factories, initiating the use of its natural sources of power to give light; and undoubtedly throughout the length and breadth of Ireland this attempt will be closely watched, and wherever water power is running to waste, sooner or later it will be utilised. It is not our intention to enter into details of the lighting here—that must be reserved for another issue—but we may say briefly the current is generated at 2,500 volts pressure, carried by overhead wires to the town five miles away, and transformed down to 50 volts. The transformed current will, when the work is finished, feed a network of low-pressure mains, from which the arc lamps lighting the streets and the incandescent lighting the interiors of the houses will be fed. It is but just to say the price of gas in Ireland, averaging six or seven shillings per 1,000 cubic feet, makes the introduction of the electric light less difficult than it might otherwise be. There is some probability of being able to compete in price, and the other advantages of electricity should bring it well to the front. There is one question which might be strongly insisted upon by those interested in the welfare and development of industrial Ireland. The example of Carlow must lead to the examination of the possibility of using this waste water power in various industries by the use of electric transmission and of motors. Coal is comparatively dear in many parts of Ireland, while water power is abundant. Surely some means may be devised of placing this hitherto waste power in the hands of users in the quantities they desire.

PROVISIONAL ORDERS.

According to the Board of Trade report just issued, 70 applications were made during the year for provisional orders. Of this number 37 were made by local authorities, and 33 by companies or individuals. Twelve of the orders relate to London. Out of the 70 applications, 59 orders have been secured. The Board of Trade seems to follow an almost hard-and-fast rule, granting without demur an order to the local authority, and refusing an order unless backed with the consent of the local authority. At any rate, only one order so opposed has been granted—in respect of a part of the parish of St. Luke, Chelsea, to the New Cadogan and Belgrave Company. Strictly speaking, however, this opposition was not to the company's application, but to clauses inserted at the instigation of the London County Council. The appendix to the report is somewhat interesting. The boom of the early eighties is still remembered, and the passing of the 1882 Bill led to a rush for orders in 1883. In that year 69 orders were granted, and of these all but 13 have been worked. Several of the 13 have really proceeded with the work—the most prominent being St. Pancras and Bradford—but others have made no movement, or so little as to be unworthy the name of work. No licenses have been applied for during the past year; the two referred to in the preceding report—viz., Chelmsford and Bath—were duly granted, and, as our readers know, both these towns are lighted. Besides these, a total of 11 licenses have been granted which have not in some way been repealed. Between 1883 and 1889 only two orders remain unrevoked, while during 1889-1890, out of 86 orders granted only two have been revoked, so that at the present time 156 orders are running, in addition to 13 licenses.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TOWNLEY'S DUPLEX ALARM.

SIR,—Having seen in your issue of to-day's date a description of Townley's duplex alarm, I should be greatly obliged if you could allow me space in your columns to state that as far back as March, 1886, I designed, and have used ever since, a practically similar combination (mounted on a neat carved bracket) comprising alarm, clock, battery, and, of course, an ordinary form bell, with the improvement of mercury cups to receive clock legs, and also, by turning a small knob, in the event of a breakdown, the electrical clock contacts were thrown out of gear and the ordinary mechanical alarm substituted.

I merely wish to show that there is no novelty attached to Townley's alarm.—Yours, etc., A. McMEEKIN.

Norwood, S.E., July 10, 1891.

SIR,—We notice in your current number a description of a new form of electric trembling bell, said to have been invented by Mr. J. Townley. We do not know when this gentleman may have invented his bell, but we beg to inform you that our Mr. W. R. Wynne patented a bell on this principle in 1885 (patent No. 7,373), and that we have been manufacturing and supplying these bells for some time. Our patent bell has fewer working parts than the one illustrated by you, and, as we believe, is a far more practicable and reliable article.—Yours, etc.,

BARNETT, WYNNE, AND BARNARD.

Newcastle-on-Tyne, July 10, 1891.

MAGNETIC BONE SEPARATOR.

Amongst the machines shown at the recent meeting of the Royal Agricultural Society at Doncaster, referred to in our notice of the show, and entered as a new implement, was the magnetic separator, which we now illustrate. This machine is intended to remove bolts, nuts, nails, horseshoes, etc., from bones, oil cake, or minerals, before they are passed into disintegrating machines, as the presence of these foreign bodies is very detrimental to the machines. The chief difficulties that had to be overcome in designing this machine were the large size and irregular shapes of the material to be treated; the fact also that the iron, particularly in bones, is frequently entangled in the bones, so that merely passing the substance once over or on to a magnet was not found sufficient to ensure the absolutely certain removal of the foreign substance. These points have been satisfactorily overcome by the use of a hollow truncated cone, with 10 internal magnets, of alternately opposite polarity. The cone revolves on outside runners, driven by friction only, which is found ample for the purpose.

demagnetised, and the iron is detached. This process is carried out by a commutating ring on the back of the machine, and the arrangement is such that each coil has one end permanently connected to one pole of the dynamo, and the other ends are in turn connected during one half a revolution to the other pole. Thus the magnets receive current in parallel. Before cutting a coil out of circuit, it is short-circuited through a resistance, and by this means no sparking of any consequence occurs.

The machine has proved itself a very practical success, and the value of the repeated revolutions over the magnets have been demonstrated by repeated trials. The power required to excite the magnets is about 600 watts for the largest size, capable of dealing with four tons of bones per hour.

The machine was exhibited by the Hardy Patent Pick Company, of Sheffield, makers of the Devil disintegrator, and was manufactured by W. T. Goolden and Co., under the joint patent of Messrs. D. and C. Atkinson and G. W. Elliott.

MILLING MACHINES.

The Britannia Company, of Colchester, recently issued a book upon "Screw-cutting and Milling Machines," which very completely went into the theory and practice of screw cutting of all kinds. Many new types of milling machines were therein illustrated, and we give on opposite page two of the most modern and improved machines, which will not fail to be of interest to electrical engineers.

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

There is no subject more captivating, more worthy of study, than nature. To understand this great mechanism, to discover the forces which are active, and the laws which govern them, is the highest aim of the intellect of man.

Nature has stored up in the universe infinite energy. The eternal recipient and transmitter of this infinite energy is the ether. The recognition of the existence of ether, and of the functions it performs, is one of the most important results of modern scientific research. The mere abandoning of the idea of action at a distance, the assumption of a medium prevadingall space and connecting all gross matter, has freed the minds of thinkers of an ever present doubt, and by opening a new horizon—new and unforeseen possibilities—has given fresh interest to phenomena with which we are familiar of old It has been a great step towards the understanding of the forces of nature and their multifold manifestations to our senses. It has been for the enlightened student of physics what the understanding of the mechanism of the firearm or of the steam engine was for the barbarian. Phenomena upon which we used to look as wonders baffling explanation we now see in a different light. The spark of an induction coil, the glow of an incandescent lamp, the manifestations of the mechanical forces of currents and magnets, are no longer beyond our grasp. Instead of the incomprehensible, as before, their observation suggests now in our minds a simple mechanism, and although as to its precise nature all is still conjecture, yet we know that the truth cannot be much longer hidden, and instinctively we feel that the understanding is dawning upon us. We still admire these beautiful phenomena, these strange forces, but we are helpless no longer; we can, in a certain measure, explain them, account for them, and we are hopeful of finally succeeding in unravelling the mystery which surrounds them.

In how far we can understand the world around us is the ultimate thought of every student of nature. The coarseness of our senses prevents us from recognising the ulterior construction of matter, and astronomy, this grandest and most positive of natural sciences, can only teach us something that happens, as it were, in our immediate neighbourhood; of the remoter portions of the boundless universe, with its numberless stars and suns, we know nothing. But far beyond the limit of perception of our senses the spirit still can guide us, and so we may hope that even these unknown worlds—infinitely small and great—may in a measure become known to us. Still, even if this knowledge should reach us, the searching mind will find a barrier, perhaps for ever unsurpassable, to the true recognition of that which seems to be, the mere appearance of which is the only and slender basis of all our philosophy.

Of all the forms of nature's immeasurable, all-pervading energy, which, ever and ever changing and moving, like a soul animates the inert universe, those of electricity and magnetism are perhaps the most fascinating. The effects of gravitation, of heat and light we observe daily, and soon we get accustomed to them, and soon they lose for us the character of the marvellous and wonderful; but electricity and magnetism, with their singular relationship, with their seemingly dual character, unique among the forces in nature, with their phenomena of attractions, repulsions and rotations, strange manifestations of mysterious agents, stimulate and excite the mind to thought and research. What is electricity? and What is magnetism? These questions have been asked again and again. The most able intellects have ceaselessly wrestled with the problem; still the question has not as yet been fully answered. But while we cannot even to-day state what these singular forces are, yet we have made good headway towards the solution of the problem. We are now confident that electric and magnetic phenomena are attributable to ether, and we are perhaps justified in saying that the effects of static electricity are effects of ether under strain, and those of dynamic electricity and electromagetism effects of ether in motion. But this still leaves the question, as to what electricity and magnetism are, unanswered.

First, we naturally enquire, What is electricity, and is there such a thing as electricity? In interpreting electric phenomena, we may speak of electricity or of an electric condition, state or effect. If we speak of electric effects, we must distinguish two such effects, opposite in character and neutralising each other, as observation shows that two such opposite effects exist. This is unavoidable, for in a medium of the properties of ether we cannot possibly exert a strain, or produce a displacement or motion of any kind, without causing in the surrounding medium an equivalent and opposite effect. But if we speak of electricity, meaning a thing, we must, I think, abandon the idea of two electricities, as the existence of two such things is highly improbable. For how can we imagine that there should be two things, equivalent in amount, alike in their properties, but of opposite character, both clinging to matter, both attracting and completely neutralising each other? Such an assumption, though suggested by many phenomena, though most convenient for explaining them, has little to commend it. If there is such a thing as electricity, there can be only one such thing, and, excess and want of that one thing, possibly; but more probably its connection determines the positive and negative character. The old theory of Franklin, though falling short in some respect, is, from a certain point of view, after all, the most plausible one. Still, in spite of this, the theory of the two electricities is generally accepted, as it apparently explains electric phenomena in a more satisfactory manner. But a theory which better explains the facts is not necessarily true. Ingenious minds will invent theories to suit observation, and almost every independent thinker has his own views on the subject.

It is not with the object of advancing an opinion, but with the desire of acquainting you better with some of the results, which I will describe, to show you the reasoning I have followed, the departures I have made—that I venture to express, in a few words, the views and convictions which have led me to these results.

I adhere to the idea that there is a thing which we have been in the habit of calling electricity. The question is, What is that thing? or, What, of all things, the existence of which we know, have we the best reason to call elecplan the installation that the cost of the power delivered shall be a minimum under any given circumstances.

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* Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

We have seen that, as judged by the efficiency standard alone, electric transmission of power in the stored form is hopelessly behind the other two methods which we compared with it. Let us now see whether this is or is not the case if we judge the system by the more practical, and, indeed, the only reliable test of cost. It is of course understood that in estimating the annual cost at so many pounds per horse-power delivered, we take into account not only the cost of coal burnt throughout the year, if we obtain the power by steam, or the rent for water, if we use a turbine, but also all other expenses which may properly be charged to the power account, such as wages for the attendants, petty stores, interest, repairs, and depreciation of plant. Estimated in this way, the cost of water power will be found to vary between £2 and £8 per annum, the exact figure depending, of course, on the total amount of power available, the quantity of water, its fall and local conditions, which must largely influence the cost of the hydraulic works. The cases where water power can be had at so low a price as £2 a year are exceptional; on the other hand, if we have to pay as much as £8 a year for water power, it will seldom be worth while to transmit it electrically, or in any other way; and I shall therefore assume £3 and £6 as the limits of cost for water power intended for electric transmission. The cost of steam power, if produced by large economical engines, is generally taken at £10 per year; if produced by small, and therefore less economical engines, it may rise to £20, and even £40 per year. I shall further assume that in all cases the power is required for 3,000 hours during the year—that is, 300 work days of 10 hours. At the outset it is clear that if we wish to transmit large parcels of power—say, 100 h.p. and upwards—by storage batteries, we must be able to deliver the power at a cost not exceeding £10 a year; for were the cost higher, it would obviously pay better to establish a local steam engine. I have already mentioned that a system of battery transmission can be made to yield 56 per cent. efficiency, if we allow 10 per cent. for the transmission itself. To deliver 100 h.p. we must, therefore, charge with 178 h.p. during a time equal to that during which the power is required. If, therefore, at the generating station the annual horse-power costs £3, the charge for power alone will be £5. 6s. at the receiving station. To this must be added the cost of labour and the interest and depreciation of plant, which, in this case, consists of the generating dynamo, motor, batteries, and line of transmission, with its equipment of locomotives and waggons. The small storage cells, as now made, for lighting and power purposes, cost about £40 per horse-power; but let us assume that the larger cells, such as we should require, could be had for £30 per horse-power, then a battery to work a 100-h.p. motor would cost £3,330. In order to economise carriage, and to reduce the wear and tear of cells, it would be advantageous to have two batteries, one being charged while the other is at work. We have thus an initial outlay of £6,660 for batteries alone. The interest and depreciation on these will certainly not be less than 15 per cent., or £10 per horse-power. Add to this the cost of power at the generating station, that of labour and interest and depreciation on the electric machinery and the line, and you will see that it is quite impossible to compete with battery transmission against a local steam engine, if the power produced by the latter costs £10 per annum. But how does the case stand, if the amount of power required is so small that it cannot be produced at this low figure. If we want only 5 h.p., and if we produce it by a local steam or gas engine, we shall have to pay for each horse-power £20 to £40 per annum. Will it in this case pay to transmit by means of batteries the power produced by a large and economical steam engine at some central station? If we have to build a tramway or railway for this purpose specially, it will certainly not pay; but let us assume that a tramway already exists, and let us investigate whether the company, which we suppose is working the line by storage cars, could afford to sell to a customer on the line power at a cheaper rate than he could produce by a local engine. Let us assume, by way of example, that the customer requires 5 h.p. for 10 hours daily. The battery to work a 5-h.p. motor will weigh about 2½ tons, and cost £170. The charging dynamo, motor, and regulating gear will cost about £150, so that the whole capital outlay, if we provide two batteries, will amount to £490.

Now let us see how such a system of transmission will have to be worked, and what the working expenses will be. I take, by way of example, five miles as the distance between the generating station, which may be the tramway depot or a central electric light station on the line of tramway, and the delivery station. At either terminus we must have mechanical appliances for loading and unloading the batteries from the car, such as are generally used in connection with storage cars. Early in the morning a charged battery is put on the car, and run out to the delivery station, where it is unloaded and connected to the motor. The other battery which has served during the previous day, is loaded on the car and taken back to the depot to be charged up again. In this manner the car need only make one journey out and one journey home daily. As its speed may be very moderate, say from three to four miles an hour, the cost of running this car will be much less than that of a passenger car, which must stop and start every few minutes, and run at a higher speed. I take 3d. per car mile as the cost of haulage, including the use of plant, and I further allow 2s. a day for labour in loading and unloading the batteries. The account of working expenses will now stand somewhat as follows:

Power at generating station at £10, allowing 65 per cent. total efficiency*	£77	0	0
Haulage	37	10	0
Labour	30	0	0
15 per cent. interest and depreciation on batteries (340)	51	0	
10 per cent. interest and depreciation on electric machinery (£150)	15	0	0
Total annual cost	£210	10	0

This works out at £42. 2s. per annum per horse-power delivered, and is therefore quite as high, if not higher, than the cost of power obtained by a small and uneconomical local engine. On the score of economy there is consequently no advantage in transmitting power by storage batteries in the present case, where the distance of transmission is five miles. Had the distance been less, the working expenses would also have come out smaller, but not by any considerable amount. The only item in which we could save is cost of haulage, and if we neglect this altogether we have still to pay £34s. 12s. per annual horse-power delivered. Battery transmission can therefore not compete against power produced by a local engine, even if the latter be of the rather uneconomical type which users of small power still tolerate. But how stands the case if for some local reason the employment of a heat engine of any kind is precluded? We have then the choice between electric transmission by means of batteries, and directly by means of a pair of wires. Which will be the more economical? As the dynamo and motor, except, perhaps, in the matter of voltage, will be the same in either case, the answer to this question turns upon the comparison of the batteries and line of wires. The first question to consider is whether our wires may in the case of direct transmission be carried overhead on poles and insulators, or must be put underground. If the former be the case, the line need not cost more than £130 per mile; and I may at once mention that from the experience gained with various power transmissions, which I hope to bring before you, this item can be estimated with a fair degree of accuracy. As I shall have to deal more in detail with the cost and construction of live power transmission plants later on, I shall not enter into details at present, and must ask you to take my statements as to cost of line and cost of power transmitted as correct, though I do not now show how the account is made up. As regards transmission by wires placed underground, there is, as far as I know, no example of such an installation, and we can therefore not verify our estimate by reference to work actually executed, as we can in the case of overhead transmission. We are thus forced to calculate the cost of the line according to the data obtainable for electric light mains, and I take for this purpose an estimate made by Mr. Crompton in his paper on "Central Station Lighting," read before the Institution of Electrical Engineers on the 12th of April, 1888. In this paper Mr. Crompton gave tables for the cost of underground mains of various types and sizes, and by reference to his tables I find that a main of the section required for the transmission of 5 h.p., and insulated so as to safely bear a pressure of 1,000 volts, would cost about £670 per mile. We have now all the necessary particulars for making a comparison of the cost of transmission and direct transmission, the latter by both overhead and underground wires. The following table gives the result. The cost includes the charge for power at the generating station (taken at £10 per annual horse-power), and interest and depreciation on the plant, which is taken at 15 per cent. for the batteries, and 10 per cent. for the line and electrical machinery.

TRANSMISSION PLANT FOR 5 H.P.

Distance of transmission in miles.	Annual cost per horse-power delivered, if the transmission is		
	By batteries.	Direct.	
		Overhead.	Underground.
	£	£	£
1	36·1	22·8	33·6
2	37·6	25·6	47·2
3	39·1	28	60
4	40·6	30·6	74
5	42·1	33	87

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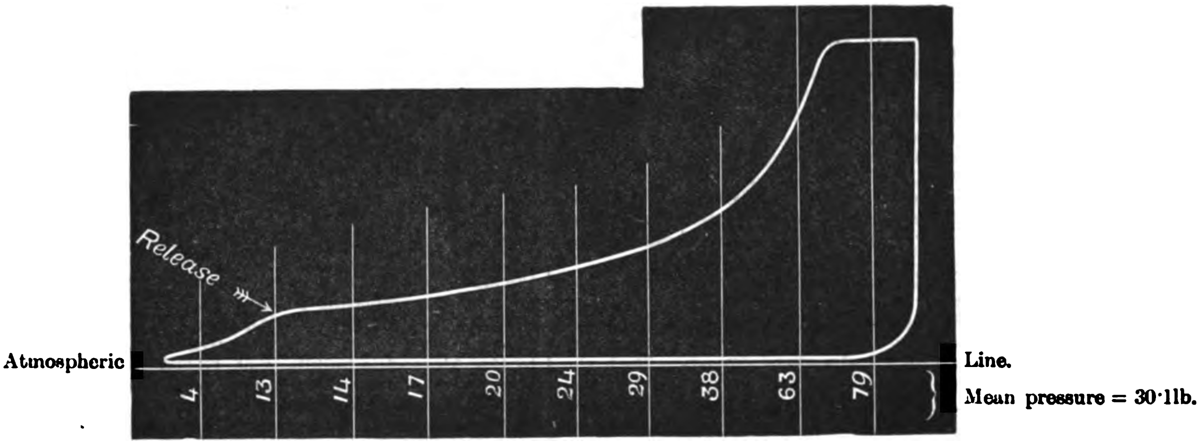
* In this case the efficiency is the ratio of the power supplied to the charging dynamo to that obtained from the motor, and does not include power spent in transmission, being charged for in the account at 3d. per car mile.

BRAKE HORSE-POWER TESTS OF BROWN'S ROTARY ENGINE.

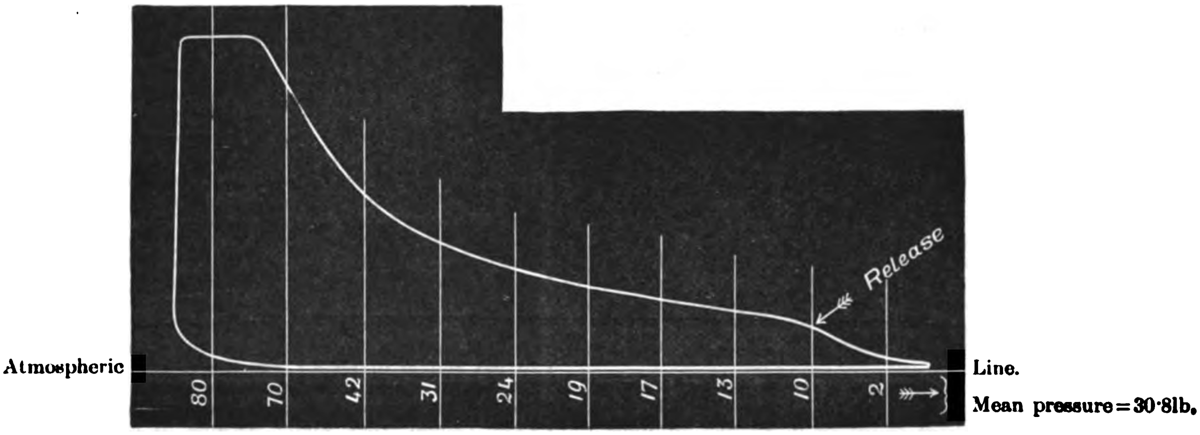
No. of reading.	Times P.M.	Boiler pressure by gauge.	Net brake load.	Revols. per minute.	B.H.P.	Remarks.
		lb.	lb.			
1	2.30	93	90	560	19·58	Each barrel full of feed-water = 305lb.
2	2.45	90	84	570	18·61	2.50 p.m., 1st barrel into boiler.
3	3.0	93	87	580	19·61	
4	3.15	93	88	580	19·84	
5	3.30	93	92	580	20·73	3.25 p.m., 2nd barrel into boiler.
6	3.45	93	92	560	20·02	3.45 p.m., 3rd ,, ,,
7	4.0	93	92	550	19·66	
8	4.15	93	90	570	19·04	4.10 p.m., 4th ,, ,,
9	4.30	93	92	570	20·38	
10	4.45	98	97	570	21·49	4.35 p.m., 5th ,, ,,
11	5.0	93	93	570	20·60	
12	5.15	96	96	580	21·64	5.5 p.m., 6th ,, ,,
13	5.30	96	96	580	21·64	Engine very steady. Brake working splendidly.
14	5.45	98	98	580	22·09	5.25 p.m., 7th barrel into boiler.
15	6.0	100	96	600	22·39	5.45 p.m., 8th ,, ,,
16	6.15	97	99	560	21·54	6.10 p.m., 9th ,, ,,
17	6.30	93	94	570	20·82	6.30 p.m., 10th ,, ,,
18	6.45	93	93	600	21·69	
19	7.0	99	102	570	22·08	6.55 p.m., 11th ,, ,,
20	7.15	98	93	590	21·32	7.20 p.m., 12th ,, ,,
						7.40 p.m., 13th ,, ,, less 16½lb.
	Means =	95	93·2	574·5	20·784	Total feed-water used in 5 hours = 3948·5lb. Gross feed-water per hour = 789·7lb. ,, ,, per B.H.P. hour = 37·9lb. ,, ,, per I.H.P. hour = 27·2lb.

Right Hand. Diagram No. 8. Boiler pressure = 95lb. by gauge. Scale spring 1" = 48lb. Taken 4.45 p.m., 4/6/91.



Indicator Card taken at 200 Revolutions per Minute from the Right-Hand Side of Brown's Rotary Engine.

Left Hand. Diagram No. 8. Boiler pressure = 95lb. by gauge. Scale spring 1" = 48lb. Taken 4.46 p.m., 4/6/91.



Indicator Card taken at 200 Revolutions per Minute from the Left-Hand Side of Brown's Rotary Engine.

Calculation for indicated horse-power and feed-water per indicated horse-power hour.

$$\text{I.H.P.} = \frac{\text{PLAN}}{33{,}000} = \frac{30{\cdot}8 \times 1{\cdot}86 \times 29{\cdot}11 \times 574{\cdot}5}{33{,}000} = 29{\cdot}02.$$

Gross feed-water used per hour = 789·7lb. Gross feed-water per I.H.P. hour = $\frac{789{\cdot}7}{29{\cdot}02}$ = 27·2lb.

lent quality, and the only oscillating parts are the valve doors, which are duly cushioned during their back strokes, and always kept bearing upon the rotating piston by steam acting from behind them. Had this higher speed been attempted, there can be no involved in that concern, and this had been attained without in the slightest degree interfering with their dividends. At the same time they had materially added to their reserve fund—that he thought was a state of things with regard to their property, that would be very difficult indeed to beat. Their African traffic last year was £49,000 less than it was two years ago, when there was a great deal of excitement there, and communication between the Cape, Kimberley, and London was very active indeed. For the moment this mining companies' traffic did not exist, but the legitimate traffic had been increasing, and the time would come round again, because there were cycles of activity and of rest, and the latter was prevailing at the present moment. There was no doubt at all that the Cape was one of the future countries to which they would have to look for a largely increased consumption of British merchandise. In a certain period these African cables would be the property of the Eastern Company, and this item would add largely to their producing power, without increasing their capital. The increase of traffic, owing to the reduction of the Australian rates, had been very satisfactory on the whole. They had not recouped themselves entirely, and he didn't expect to do so within 18 months or two years. But they had so far recouped themselves, that when the end of the year came they were very likely to carry on the experiment. The Cape had applied to be put on the same footing as Australia, but that required some negotiation. He would like to see one experiment thoroughly tested before they entered upon another. In conclusion, he alluded to his recent visit to the Mediterranean stations, and to the good order in which he found them, as well as the happy relations which existed between the Turkish and Grecian Governments and the Company's officials. He then moved the adoption of the report and accounts, and declaration of the dividend (*vide* report).

This was seconded by the **Marquis of Tweeddale**, and carried unanimously.

In answer to a shareholder, the **Chairman** said that the latest of the three cables between Aden and Bombay was laid to the southward of the others.

A vote of thanks to the Chairman, proposed by **Mr. Griffiths**, concluded the proceedings.

CHILI TELEPHONE COMPANY.

The ordinary general meeting of this Company was held on Tuesday at Winchester House, Colonel R. R. Jackson presiding.

The **Chairman** stated that the gross revenue of the Company had increased from £26,310 to £38,711, or 47 per cent., and the working expenses from £15,996 to £19,506, or only 22½ per cent. The cost of working had fallen from 61 per cent. upon the gross revenue to 50 per cent., and with the increase of the gross revenue and the diminution of the expenditure, the net revenue showed an increase from £10,314 to £19,205, or 86 per cent. Had it not been for the fall in the exchange of 25 per cent., the earnings would have been equal to 8½ per cent. upon the capital. Sufficient profit was made to pay a dividend at the rate of 7 per cent. per annum, but, taking into consideration the state of affairs in Chili, the Directors thought it wise to carry the whole amount forward. The number of subscribers had increased by 965. The expenditure on development in Valparaiso and Santiago had been very heavy. At the outbreak of the civil war the Government took over the business, but would compensate the Company in respect of any loss. He moved the adoption of the report and accounts, which was duly seconded and carried.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY.

The half-yearly general meeting of this Company was held on Tuesday, at the offices, 38, Old Broad-street, Sir George Elliott, M.P., presiding.

The **Chairman** stated that during the last six months they had been employed principally in completing contracts entered into in 1890—that was, in finishing the manufacture of and in laying the Eastern Company's cables between Aden and Bombay, and the Eastern Extension Company's cables between Madras and Penang. Both of these operations were successfully carried out in the months of March and April last. Their cable factories were still at work completing a contract for the Great Northern Company. Their general current business continued to be satisfactory. They only went into the question of their accounts once a year, and that was the whole of the business of the meeting that day.

The meeting then separated.

COMPANIES' REPORTS.

DIRECT UNITED STATES CABLE COMPANY.

The half-yearly report of this Company states that the half-year's revenue, after deducting out-payments, amounted to £37,352. 19s. 5d., against £40,017. 1s. for the corresponding period of 1890, being a difference of £2,664. 1s. 7d., against the half-year under review. The working and other expenses for the same period, exclusive of cost of repairs of cables, amounted to £18,112. 19s. 8d., leaving a balance of £19,239. 19s. 9d. as the net profit of the half-year, making, with £5,510. 11s. 3d. brought forward from the previous half-year, a total of £24,750. 11s. For the corresponding period of 1890 the working expenses and other payments amounted to £17,616. 5s. 8d. Three quarterly interim dividends of 3s. 6d. each per share, amounting to £31,872. 15s., have been declared and paid during the financial year, and a final payment of 3s. 6d. per share is now proposed, making, with the three interim dividends, 3½ per cent. for the year, being a total distribution of £42,497. The balance of £3,502. 1s. on the revenue account is proposed to be carried forward.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY.

Directors: James Staats Forbes, Esq., chairman; Frederick Richards Leyland, Esq., deputy-chairman; Viscount Anson; Shelford Bidwell, Esq., F.R.S.; Ernest Villiers, Esq.

Report of the Directors to be presented to the shareholders at the annual meeting to be held at the Westminster Palace Hotel, Victoria-street, S.W., on Tuesday, July 21, at 12 o'clock.

The Directors have the pleasure of presenting to the shareholders their report and the accounts for the year ending June 30, 1891. The business of the Company has resulted in a credit balance of £72,905. 4s. 7d., out of which the Directors have appropriated the sum of £3,425. 14s. 8d. to meet loss on realisation of dynamo account, taken over at the amalgamation; and £12,371. 14s. 7d. has been absorbed by the payment of an interim dividend on the A shares at the rate of 7 per cent. per annum for the first six months of the year. The Directors recommend the payment of the following dividends on the A shares, free of income tax, and to be distributed in accordance with clause 87 of the articles of association: (*a*) At the rate of 7 per cent. per annum for the half-year ending June 30, 1891 (making 7 per cent. for the year). (*b*) 3 per cent. in completion of payment of arrears of cumulative preference dividend for the year ending June 30, 1885. (*c*) 7 per cent. in payment of arrears of cumulative preference dividend for the year ending June 30, 1886, which will absorb £47,719. 10s. 7d., leaving £9,388. 4s. 9d., which the Directors have carried to the reserve fund, in accordance with clause 89 of the articles of association. The Directors have granted licenses to several electrical firms and companies to manufacture holders and sockets for incandescent electric lamps under the Company's patents. This branch of the business will increase as electric lighting increases, and will bring a satisfactory addition to the revenue of the Company. Mr. J. S. Forbes and Mr. F. R. Leyland retire from the Board in rotation, and offer themselves for re-election as directors. The auditors, Messrs. Welton, Jones, and Co., retire, and are eligible for re-election.

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDED 30TH JUNE, 1891.

Dr.	£	s.	d.
Stock on hand, 1st July, 1890	56,266	8	10
Wages, purchases, etc.	56,362	19	6
Salaries, Directors' remuneration, rent, office expenses, insurance, income tax, general and law charges	15,270	6	7
Depreciation on plant, etc.	2,160	18	10
Balance	72,905	4	7
	£202,965	18	4

Cr.	£	s.	d.
Sale of lamps, fittings, royalty on holders, etc. ...	143,229	14	11
Interest, etc.	427	12	0
Stock on June 30th, 1891................................	59,308	11	5
	£202,965	18	4

BALANCE-SHEET, JUNE 30, 1891.

Dr.	£	s.	d.	£	s.	d.
Share Capital—5,000 A shares of £5 each, fully paid, allotted to the Edison Electric Light Company, Limited	25,000	0	0			
12,139 A shares of £5 each, fully paid, allotted to the Swan United Electric Light Company, Limited, ranking up to 5 per cent. for dividend on the amount credited as paid up, and afterwards equally, per share, with A shares partly paid..........	60,695	0	0			
89,261 A shares, £5 each, £3 paid...	267,783	0	0			
23,564 B shares, £5 each, fully paid	117,820	0	0			
				471,298	0	0
The B shares are entitled to one-fourth of the profits, after a cumulative preferential dividend of 7 per cent. per annum has been paid on the A shares. (The preferential cumulative dividend of 7 per cent. amounted, on June 30, 1891, to £82,491 12s. 4d.)						
Sundry credit balances				14,706	19	4
Reserve fund........				12,689	0	3
Profit and loss as per appropriation account	69,479	9	11			
Less interim dividend at the rate of 7 per cent. per annum for six months ended December 31, 1890, paid on February 20, 1891	12,371	14	7			
				57,107	15	4
				£555,801	14	11

NOTES.

Richmond.—Tenders for wiring Richmond Town Hall, if sent, must be sent in by August 4.

Bournemouth wants the opinion of an electrical engineer as to lighting its pier with electric light.

Aylesbury.—The tenders for public lighting must be sent in by the 31st inst. to Mr. G. Fell, Aylesbury.

Writing Telegraph.—When Prof. Elisha Gray's writing telegraph becomes practical, "autogram" is proposed as the word to use.

Palermo Exhibition.—The contract for five dynamos for lighting the forthcoming exhibition at Palermo has been given to Messrs. Siemens and Halske.

Accumulator Patent.—The judgment given against M. Paul Gadot with reference to accumulators has been confirmed in the French Superior Court.

Burnley.—A new infirmary is to be erected at Burnley. Mr. Keighley, the architect, should be supplied with material for estimating the inclusion of electric light.

Colombo Tramway.—It is thought that the Contract Construction Company, who have the new tramway in Colombo in hand, will use compressed air as the motive power.

Northampton.—Messrs. Jeffery and Holden, architects, have given the contract to decorate the Northampton Town Hall to Messrs. Campbell and Smith. Electric light should be included.

Blackburn.—A new orphanage is being built at Wilpshire, Blackburn—architects, Messrs. Briggs and Wolstenholme—a possible opening for gas engine and accumulators.

North London.—The promoters of the North London Electric Lighting Order having failed to comply with certain conditions, the order has been revoked by the Board of Trade.

Cromwell-road. — Consent of the London County Council has been given to the extension of mains in Gloucester-road and Cromwell-road by the Kensington and Knightsbridge Company.

Harlow.—Tenders are invited for the public lighting of Harlow, from Sept., 1891, to April, 1892, from dusk to 11 p.m., and cleaning and storing lanterns. Particulars of Mr. W. E. Deards, Broadway, Harlow.

Electric Tramways in Norway.—A syndicate was recently formed in Christiania for the introduction of an electric tramway, and a deputation has visited Berlin, Frankfort, and Halle to report upon the systems there in use.

Austrian Telegraphs.—A universal telegraph tariff has been arranged between Austria and Germany. The charge is 3 kreuzer (·6d.) per word, with a minimum of 30 kreuzer (6d.). This tariff will come into force at the beginning of 1892.

Lighting an Artillery Encampment.—The Monmouthshire Artillery Brigade go into camp at Abergavenny on Tuesday next, and the annual inspection takes place on Bank Holiday. The camp will be lighted by electricity, the current being supplied by the Risca batteries.

Double Filament Lamp. — Herr Hiel, in the *Elektrotechnisches Echo*, No. 28, describes an arrangement for series incandescent lighting, of an incandescent lamp with two filaments, combined with an automatic switch to come into action on the failure of the first filament.

Telegraph Extension.—In answer to a question, Mr. Raikes stated in the House of Commons that by an amendment in the Post Office Bill, of which he has given notice, power will be given to local authorities to guarantee the cost of extensions of telegraph wires in districts in which they may be needed.

The Royal Society of Edinburgh.—The last ordinary meeting of the session of the Royal Society of Edinburgh was held on Monday at the Royal Institution, Lord M'Laren in the chair. A paper was read on the "Effect of Longitudinal Magnetisation on the Interior Volume of Iron and Nickel Tubes," by Prof. Knott.

Huddersfield.—The Gas Committee of the Huddersfield Corporation reported to the County Council on Wednesday that they met on the 1st inst. and decided to accept the amended tender of the Brush Electrical Engineering Company, Limited, for the installation of the electric lighting in Huddersfield at a cost of £20,640.

Saunderson Arc Lamps.—With reference to the use of hydrocarbon vapour in arc lamp carbons, and Dr Hopkinson's and Prof. Thompson's remarks there—anent, the *Bulletin de l'Electricité* hopes some third electrician will take up the question, and demonstrate whether the presence of gas on the arc is really an advantage or the reverse.

Thunderstorms.—Severe thunderstorms were experienced throughout the country at the end of last week. At Coventry the chimney of a large house was cut off level with the roof. At Nuneaton the flagstaff on Messrs. Hall and Phillips's hat factory was cleared as if by a hatchet, one half remaining, while the other half fell and damaged the roof.

Swindon.—The New Swindon Local Board have had the consideration of the Electric Lighting Acts before them. The question was left to obtain further particulars. Mr. A. D. Williams wrote to state his intention to lay down a dynamo and engine, and asked permission of the Board to take a wire across the street at the level of the present telephone wire. The Board acceded to the application.

London Chamber of Commerce.—A meeting of the council was held on Monday, Sir A. Rollit, M.P., presiding. A deputation of the Chicago World's Fair was introduced by Sir P. Cunliffe Owen, and was promised support. A deputation from the telephone companies was next received on the subject of an improved service, which was referred to a committee of the Chamber for further investigation.

Paddington.— Letters were read at last week's meeting of the Paddington Vestry from the Paddington and Bayswater Electric Light and Power Supply, Limited, and the London Electric Lighting Company, Limited, announcing their intention respectively of applying for a provisional order to supply electricity in this parish. It was decided to instruct the solicitor to oppose in both cases.

Ship Lighting.—Sir William Thomson in an interesting letter to the *Electrical Review* points out that, as regards disturbance of ship's compasses, the concentric wiring has no advantage over the one-wire system unless the outer sheathing is insulated sufficiently to prevent the return current spreading over the ship. A moderate degree of insulation, such as mounting on dry wood, would be sufficient.

Goole.—Tenders for lighting are required, for 12 months, from September 30, by the Goole Local Board. Gas is asked for, but electric light might also be acceptable. Mr. G. England is the clerk, and tenders are wanted by August 11. Goole is to have new goods offices for the Lancashire o light the district by electricity, and Messrs. Parfitt's ender of £550 was accepted.

Electric Railways.—The following interesting bits re given in Mr. F. Brown's report to the Walsall Corporation. Mr. F. Sprague stated to him that there had not been a single fatal accident from current used on electric railways. At St. Paul's, Minneapolis, he found 1,200-h.p. engines driving 12 dynamos, providing current for 135 motor cars, running on 46 miles of double track. The boilers are Babcock and Wilcox, fired by oil at two cents a gallon. The electric cars have run the ordinary steam railway off the road, giving better service at half cost. At Cleveland he found a car passed every six seconds, or about 11 a minute, all well loaded. At Buffalo they have 80 miles at work and 50 more are going down, with a total of 300 cars. At Pittsburgh the Pleasant Valley Company have 780 h.p. at work. The Perrysville line is one of the most difficult in America, being all uphill, a gradient of 12½ per cent., or one in eight, and curves all the way of short radius. The car travelled well at six to eight miles an hour, starting on the curves and without jerks. At moment of starting each car took about 80 h.p. He learnt that in every lawsuit decision about earth circuits the decision had gone with the tramway company.

Illuminating Efficiency of Lamps.—M. A. Witz has communicated to the French Académie des Sciences the result of his researches upon the illuminating efficiency of some of the ordinary forms of lighting apparatus. The following comparative table is obtained :

Source.	Expenditure.	Intensity.		Calories.	
		Carcel.	Candle.	Per carcel-hour.	Per candle-hour.
"L'Etoile" candle...	10·5 gr. pr. hr.	1/6·5	1·4	716	79·5
"Bengel" gas burner	105 litres ,,	1	9	567	63
Recuperative	35 ,, ,,	1	9	189	21
Incandescent electric lamp	3·5 watts per candle	1/6·5	1·4	20	2·22
Arc lamp	·5 ,, ,,	1	9	4	·44

The best absolute efficiency is, of course, that of the arc lamp.

It is more economical to burn gas on an engine for the production of electric light than to use it direct in gas burners, M. Witz concludes. He has substituted 16 arcs and 71 16-c.p. incandescents for six large double recuperative gas lamps, 91 ordinary jets, and 19 batswing burners. Exact measurement showed this electric light to give 15 per cent. more light than the gas lamps for the gas ; and the engine driving the dynamo consumed only 21,500 litres of gas against 26,000 litres per hour of the gas lamps.

Austrian Companies.—Last week the electrical companies in Vienna published for the first time, says the Vienna correspondent of *Industries*, their reports on the progress of business during the past year. The Vienna Electricity Company, which employs the machinery of Messrs. Siemens and Halske, though it has been working for a year and a half, is not yet in a condition to pay a dividend. There is, however, no deficit, and £23,440 was carried forward to next year's account. The International Electricity Company, which employs Messrs. Ganz and Co.'s machinery, has paid interest out of capital at the rate of 5 per cent. on its capital of £281,250. As the company has spent £168,000 on its Vienna central station, whose cable system is 22 miles in length, and on its central station at Fiume, this rate of interest was much too high. The first balance-sheet of the company consequently shows a deficit of £4,213. On the whole, these companies have done a fairly satisfactory business during the past year. On the Stock Exchange, however, electrical companies have lost credit to some extent, and the Anglo-Austrian Bank has been obliged on this account to postpone the intended issue of shares of the Budapest Electrical Railway. The Prague Electrical Tramway, worked on the system of Herr Krizik, who is the inventor of the well-known Pilsen arc lamp, has been completed, and the preliminary trials of the tramway took place on the 8th inst.

York.—An adjourned meeting of the York City Council was held on Tuesday to consider the electric lighting of the York Law Courts. Alderman Agar moved the adoption of the report of the Municipal Offices Committee, who recommended that the courts of justice, police stations, etc., in Clifford-street, be lighted by electricity, and that the tender of Messrs. Benham and Sons, London, at the sum of £552. 11s., according to specifications submitted by Mr. Sydney Hargraves, electrical engineer, New Bridge-street, London, be accepted, and that Mr. Hargraves be appointed electrical engineer in connection with the wiring of the building, his remuneration to be 35 guineas, to include all charges for revising specifications and plans, reporting on estimates, superintending the wiring, testing and passing the same on completion, and all travelling and incidental expenses. Mr. Mansfield moved as an amendment that the report be referred back to the committee, and Mr. Tripp, in seconding the amendment, complained that the committee had come before the Council with a report recommending electricity when they were not prepared to say whether gas or electricity was the cheapest. Mr. Dodsworth said it was intended by the committee that the plant for lighting the public building should be part of the system for lighting the whole city. Mr. Dickenson thought they would do well to see whether they could themselves successfully carry out the electric lighting of their building. Mr. Mann also moved another amendment, to adopt the report of the committee, and providing also that the police station and fire brigade buildings be lighted with gas, as well as having the electric wire laid on. The amendment was negatived, and the report was adopted.

Safety in Theatres.—We have received from Mr. S. Wilkins, Mansion House-chambers, E.C., a small pamphlet (1s.) by M. Réné Résuche, upon "Crushes and Crowds in Theatres in Cases of Fire or Fright," describing a method which the inventor is seeking to introduce for the better safety of theatres. M. Résuche gives some interesting and suggestive figures both of the numerous fires, amounting to 32 in 1889, and 50 in 1890, in theatres in various parts of the world, together with a table of the total receipts from the theatres of Paris, which goes to show that although there has been a steady rise in receipts (barring the war years) from 1848 to 1884, yet in 1885 accounts were everywhere current of several very disastrous fires, and since then, even during the exhibition year, the receipts have been going down, till there is now a deficit of nearly three-quarters of a million sterling from the calculated average. This is almost entirely due, he thinks, to the fear of fire, and he urges theatre proprietors to make such arrangements as shall ensure absolute safety and ease of exit. He has constructed models in which movable doors or walls of double iron plates filled in with cork or other material are built at suitable places in the outside walls. These either drop down like shutters, giving exit to outside balconies, or, in another model, fall outward like drawbridges, themselves forming a balcony. In case of panic these are all loosed simultaneously by electric or pneumatic contact, and the public find everywhere around them exits to the outside staircases. Panic would thus be avoided, and safety could be assured without the necessity for entire reconstruction of the whole premises, as now seems the only alternatvie. The pamphlet is well worthy of study by those associated with theatre working, and M. Résuche adduces very favourable comments from the Paris papers.

There can be no doubt that an inexpensive, light, and mechanically solid storage battery is a great desideratum, as there is at the present time a large and increasing demand for portable batteries suitable for such purposes as safety lamps, such as are used in coal mines, petroleum ships, gunpowder mills, gas works, etc. For tramcar propulsion, electric buses, electric launches, and submarine boats, and also for supplying the energy for train, carriage, and other forms of portable electric lighting, a battery capable of withstanding a considerable amount of jolting and rough treatment is much needed. A large number of portable storage batteries are now being employed both in the army and navy, but it is found that the rough treatment they receive seriously tell upon them.

As the battery we have just described seems to possess most of the essentials of a really good portable medium for storing electrical energy, it should be found of much service for the purposes we have enumerated.

In the new cell the whole of the active material is held solidly in position, and cannot move, and it therefore follows that the necessary current collectors may be very light, and in practice it is found that a very high current capacity per pound of complete cell may safely be obtained.

One of the small cells we were shown was constructed for traction purposes, and as an indication of its capabilities the following data is given:

Height	7½in.
Breadth	5in.
Width	5in.
Total weight	11lb. 7oz.
Best rate of charge	5 to 10 amperes.
Best rate of discharge	3 to 6 amperes.
Working current capacity......	30 ampere-hours.
Working energy capacity......	60 watt-hours.

A small two-cell battery, made for such purposes as safety hand-lamps, etc., was of the following dimensions:

Height	5in.
Breadth	3¾in.
Width	1⅞in.
Total weight	2lb. 10oz.
Best rate of charge	1 to 2 amperes.
Best rate of discharge	0·5 to 1·0 ampere.
Working current capacity ...	3 ampere-hours.
Working energy capacity ...	12 watt-hours.

These batteries were of the Planté type, and were simply formed by the ordinary process of charging and reversing. Naturally, as the size and capacity increases the comparative weight decreases. The cells shown to us consisted of a light leaden chamber, forming the negative pole, and these were firmly cemented into a strong wooden outside case. Special terminals, which are really elongations of the electrodes, are used. As an example of the mechanical solidity of the Niblett accumulator, the cell exhibited was thrown with some violence several times to the floor without suffering the least injury.

ELECTRIC LIGHTING IN LONDON.

Mr. R. Percy Sellon, M.I.E.E., at the last weekly meeting of the Balloon Society in St. James's Hall, gave an address on the above subject. He gave a sketch of the early history of electric light, and of the first Electric Lighting Act of 1882. Six years later the Electric Lighting Act of 1888 was passed, extending the period of tenure from 21 to 42 years, which, though far from placing electric lighting on the favourable conditions under which gas started, has resulted in an immense development. Nine companies and one local authority are now supplying electricity over the greater part of London, with an aggregate capital of £3,000,000, and already some are paying dividends. The equivalent of half a million lamps of 8 c.p. are now distributed, and additions are being rapidly made; some of the largest have trebled and quadrupled their production within the last 12 months. Mr. Percy Sellon described very fully the contract entered into between the Commissioners of Sewers of the City of London and the Brush and the Laing-Wharton Companies, which constitutes a scheme of an unusually comprehensive character. As regards public lighting, it is the first instance in this country where a public authority has courageously determined to wholly abandon other illuminants in its streets, large and small, in favour of electric lighting. Arc lamps to be placed in the main thoroughfares, and incandescent lamps in the side streets. Then under an extensive scheme of private lighting, current will be supplied to offices, warehouses, and business premises. Upon the question of cost, Mr. Sellon expressed his opinion that the adoption or otherwise of electric light would turn less upon a question of actual cost in pounds, shillings, and pence per quarter than upon a higher standard of comfort among the people. The fact that the City authorities are willing to pay more than twice as much for public lighting by electricity as they have paid previously for gas, points to this conclusion. Mr. Sellon then dealt with the question of danger to life and fire risk, showing that the Board of Trade and fire office rules had rendered these less than than those of gas or oil. At the conclusion of the paper a resolution was carried that it was not desirable that the Legislature should unduly interfere with the development of the electric lighting industry.

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

(Continued from page 64.)

But of all the views on nature, the one which assumes one matter and one force, and a perfect uniformity throughout, is the most scientific and most likely to be true. An infinitesimal world, with the molecules and their atoms spinning and moving in orbits, in much the same manner as celestial bodies, carrying with them and probably spinning with them ether, or in other words, carrying with them static charges, seems to my mind the most probable view, and one which, in a plausible manner, accounts for most of the phenomena observed. The spinning of the molecules and their ether sets up ether tensions or electrostatic strains; the equalisations of ether tensions sets up ether motions or electric currents, and the orbital movements produce the effects of electro and permanent magnetism.

About 15 years ago Prof. Rowland demonstrated a most interesting and important fact—namely, that a static charge carried around produces the effects of an electric current. Leaving out of consideration the precise nature of the mechanism which produces the attraction and repulsion of currents, and conceiving the electrostatically charged molecules in motion, this experimental fact gives us a fair idea of magnetism. We can conceive lines or tubes of force which physically exist, being formed of rows of directed moving molecules; we can see that these lines must be closed; that they must tend to shorten and expand, etc. It likewise explains in a reasonable way the most puzzling phenomenon of all, permanent magnetism, and, in general, has all the beauties of the Ampère theory without possessing the vital defect of the same—namely, the assumption of molecular currents. Without enlarging further upon the subject, I would say that I look upon all electrostatic current and magnetic phenomena as being due to electrostatic molecular forces.

The preceding remarks I have deemed necessary to a full understanding of the subject as it presents itself to my mind.

Of all these phenomena the most important to study are the current phenomena, on account of the already extensive and ever-growing use of currents for industrial purposes. It is now a century since the first practical source of current has been produced, and ever since the phenomena which accompany the flow of currents have been diligently studied, and through the untiring efforts of scientific men several layers of fine, well annealed iron wire, which, when wound, is passed through shellac. The armature wires are wound around brass pins, wrapped with silk thread. The diameter of the armature wire in this type of machine should not be more than one-sixth of the thickness of the pole projections, else the local action will be considerable.

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* Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

Fig. 2 represents a larger machine of a different type. The field-magnet of this machine consists of two like parts which either enclose an exciting coil, or else are independently wound. Each part has 480 pole projections, the projections of one facing those of the other. The armature consists of a wheel of hard bronze, carrying the conductors which revolve between the projections of the field magnet. To wind the armature conductors, I have found it most convenient to proceed in the following manner: I construct a ring of hard bronze of the required size. This ring and the rim of the wheel are provided with the proper number of pins, and both fastened upon a plate. The armature conductors being wound, the pins are cut off and the ends of the conductors fastened by two rings which screw to the bronze ring and the rim of the wheel respectively. The whole may then be taken off and forms a solid structure.

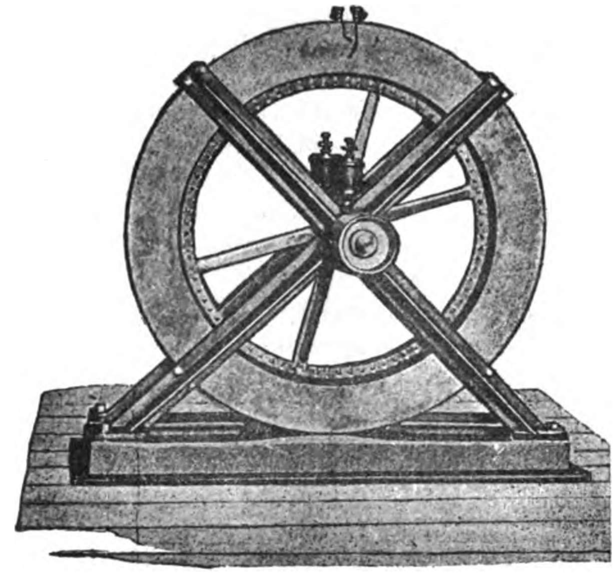

FIG. 2.

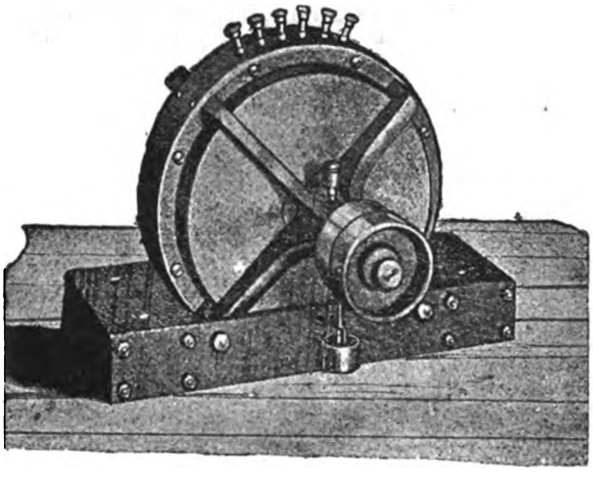

FIG. 3.

The conductors in such a type of machine should consist of sheet copper, the thickness of which, of course, depends on the thickness of the pole projections; or else twisted thin wires should be employed.

Fig. 3 is a smaller machine, in many respects similar to the former, only here the armature conductors and the exciting coil are kept stationary, while only a block of wrought iron is revolved.

It would be uselessly lengthening this description were I to dwell more on the details of construction of these machines. Besides, they have been described somewhat more elaborately in the N.Y. *Electrical Engineer* of March 18, 1891. I deem it well, however, to call the attention of the investigator to two things, the importance of which, though self-evident, he is nevertheless apt to underestimate; namely, to the local action in the conductors, which must be carefully avoided, and to the clearance, which must be small. I may add, that since it is desirable to use very high peripheral speeds, the armature should be of very large diameter in order to avoid impracticable belt speeds. Of the several types of these machines which have been constructed by me, I have found that the type illustrated in Fig. 1 caused me the least trouble in construction, as well as in maintenance, and, on the whole, it has been a good experimental machine.

In operating an induction coil with very rapidly alternating currents, among the first luminous phenomena noticed are naturally those presented by the high-tension discharge. As the number of alternations per second is increased, or as—the number being high—the current through the primary is varied, the discharge gradually changes in appearance. It would be difficult to describe the minor changes which occur, and the conditions which bring them about, but one may note five distinct forms of the discharge.

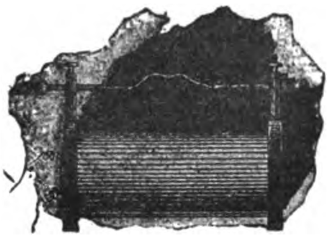

FIG. 4.

First, one may observe a weak, sensitive discharge in the form of a thin, feeble coloured thread, Fig. 4. It always occurs when, the number of alternations per second being high, the current through the primary is very small. In spite of the excessively small current, the rate of change is great, and the difference of potential at the terminals of the secondary is therefore considerable, so that the arc is established at great distance; but the quantity of "electricity" set in motion is insignificant, barely sufficient to maintain a thin, threadlike arc. It is excessively sensitive and may be made so to such a degree that the mere act of breathing near the coil will affect it, and unless it is perfectly well protected from currents of air, it wriggles around constantly. Nevertheless, it is in this form excessively persistent, and when the terminals are approached to, say, one-third of the striking distance, it can be blown out only with difficulty. This exceptional persistency, when short, is largely due to the arc being excessively thin; presenting, therefore, a very small surface to the blast. Its great sensitiveness, when very long, is probably due to the motion of the particles of dust suspended in the air.

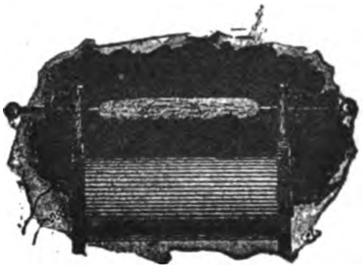

FIG. 5.

When the current through the primary is increased, the discharge gets broader and stronger, and the effect of the capacity of the coil becomes visible until, finally, under proper conditions, a white flaming arc, Fig. 5, often as thick as one's finger, and striking across the whole coil, is produced. It develops remarkable heat, and may be further characterised by the absence of the high note which accompanies the less powerful discharges. To take a shock from the coil under these conditions would not be advisable, although under different conditions, the potential being much higher, a shock from the coil may be taken with impunity.

(To be continued.)

similarly only require three or four lamps. From a network these small consumers can be supplied as economically as the larger consumers can with their own transformers. Will the small consumers patronise the light? is a question that has yet to be answered. We think they will, and Messrs. Gordon and Co.'s experience at Carlow will be watched with some interest to see if the surmise is correct.

THE LATE WILLOUGHBY SMITH.

It is with deep and sincere regret that we have to record the death of Mr. Willoughby Smith. A short time since we chronicled the death of David Brooks, an American telegraphic pioneer. Now one of our own pioneers has gone, thinning the meagre ranks of those whose exertions and energy made submarine telegraphy practical. Quite recently, too, our late friend completed and issued his monograph on the development of cable work. Before briefly sketching his career we may be permitted to speak of the man as a friend. After all, there is a something which appeals forcibly to older men—casting a glamour upon those good old days when, younger and more vigorous, they were pushing ahead in their career, surrounded by congenial companions, whose faces as time rolls on are seen less and less frequently, till they enter the great unknown. Among a small crowd of young men Willoughby Smith was not the least prominent. His friendship was not given hastily, but when given it was that of a "friend in need." His principle was to speak of men, and act towards them, as he found them, and not from hearsay would he withdraw one atom of the confidence he reposed in his friend. True as steel, gentle, and considerate, though never permitting an imposition, he gradually passed, as we say, into the front rank of those connected with cable work. As long ago as 1848 Willoughby Smith entered the service of the Gutta Percha Company, and soon after this date the Gutta Percha Company commenced experimenting with a view to covering iron or copper wires with guttapercha for telegraphic or other electric purposes. In 1849 they had so far succeeded with these experiments that they undertook to supply 30 miles of copper wire covered with a thick coating of guttapercha, to be laid from Dover to Calais, with a view to practically demonstrating the feasibility of submarine telegraphy. During the years 1849-50 Mr. Smith was busily engaged in the manufacture and laying of this line. The trouble and annoyance caused by the imperfect system of making the joints in the experimental line induced Mr. Smith to give this subject his special attention, and in the cable laid over the same course in the following year (in the manufacture and laying of which he was engaged) he introduced a system of joint making which proved a great success, and in 1855 the present system of joining and insulating the conductor.

From this time onward he was constantly engaged either with cable work or with underground land lines. Early in 1854 the first cable to be laid in the Mediterranean was commenced. Mr. Smith had charge of the electrical department during its manufacture, and assisted Prof. Wheatstone with his experiments on the retardation of signals through this cable, while coiled at the works of Messrs. Glass, Elliott, and Co., East Greenwich. These experiments were made for the purpose of verifying or correcting the results of similar experiments which had been made by Prof. Faraday on lengths of the core of this cable at the Gutta Percha Company's works earlier in the same year. Mr. Smith took charge of the electrical department during the laying of this cable between Spezzia and Corsica, Corsica and Sardinia, and in the following year was similarly employed in the manufacture and laying of a cable between Sardinia and Bona. During the manufacture of this cable Dr. Whitehouse made experiments with it to obtain trustworthy data for giving suitable proportions for the core of an Atlantic cable which was then in contemplation. On Mr. Smith's return from this expedition he remained at home as electrician and manager of the wire department at the Gutta Percha Works, and at once commenced to prepare for the manufacture of 2,500 miles of core for a cable which was to be laid from Ireland to Newfoundland. In 1851, after the manufacture of the single-covered copper wire already referred to as having been laid from Dover to Calais, it was thought advisable to apply the guttapercha in two or more thin, instead of one thick covering, and to ensure adhesion between these separate coverings coal-tar naphtha was employed. But time showed that so strong a solvent of guttapercha was very prejudicial to its durability, and in 1858 Mr. Willoughby Smith invented an insulating and adhesive compound suitable for application between each covering of the guttapercha, instead of the coal-tar naphtha. This compound was soon adopted, and is in general use at the present time. In 1864 the works of Messrs. Glass, Elliot, and Co., at Greenwich, and the Gutta Percha Company, were formed into "The Telegraph Construction and Maintenance Company," Mr. Smith retaining his position at the Gutta Percha Works. In 1865 the late Sir Richard Glass, the then managing director of the Telegraph Construction and Maintenance Company, requested Mr. Smith to accompany the "Great Eastern," and render assistance, if necessary, in the laying of the cable from Ireland to Newfoundland. Early in 1866 Mr. Smith was appointed chief electrician to the Telegraph Construction and Maintenance Company, and in that capacity was engaged on board the "Great Eastern" during the successful laying of the cable from Ireland to Newfoundland, and the recovery and completion of the cable lost the previous year. Mr. Smith's new system was adopted on that occasion. On the completion of the cables, Mr. Smith applied his system to their working, and before he left the station at Heart's Content to return home in the "Great Eastern," he had the pleasure of seeing a speed of 13 words per minute obtained on each cable.

Subsequently, Mr. Willoughby Smith took charge of the French Atlantic cable expedition. The cable was successfully laid, but the strain had been too great, and the chief electrician was for some time incapacitated from work. After his recovery he experimented upon and improved the manufacture of guttapercha for cable work. But is not his life-long work well set forth in his recently published book? and to it our readers should turn to see what progress was made in one industry during a lifetime. Mr. Willoughby Smith was a fairly prolific writer, contributing to periodical literature, and to the *Journal* of the Institution of Telegraph Engineers, of which he was president in 1882-3. It was not till after about 40 years of active service that Mr. Smith severed his connection with cable work.

His remains were interred at the Highgate Cemetery on Wednesday, in the presence of a large number of friends. The Institution in which he had taken so great an interest was represented by Prof. W. Crookes, F.R.S., president; Prof. Cary-Foster, F.R.S., vice-president; and Mr. F. H. Webb, secretary.

CREOSOTING TIMBER.*

BY E. J. SILCOCK, A.M.I.C.E., F.G.S., BOROUGH ENGINEER, KING'S LYNN.

(Concluded from page 55.)

Boulton's process is an improvement in another direction. Having extracted a large portion of the sap in the shape of steam, there is not such a large quantity of albumenoid matter to coagulate, so that the quantity of tar acids may be reduced, and oils of an inferior quality may be used without decreasing the efficiency of the treatment. This is important, as the tar acids are now very largely extracted from the creosote oils for other commercial purposes, and with ordinary London oils the percentage of tar acids is not as high as prudence would dictate if all the sap in young timber is left in. The plant required for Blythe's process by the looping. In other words, that we can, by these simple means, convert mechanical into electrical power, or electrical into mechanical power. If we carry out both processes at the same time—that is, if we combine Faraday's with Oersted's experiment—we require, of course, a pair of wires between the two converting instruments. In Faraday's experiment, if we thrust the steel magnet into the wire coil, we expend mechanical power, which is converted into the electrical power represented by a current flowing under a certain, though in this case very small, potential difference. The power represented by this current is again reconverted in Oersted's experiment into mechanical power, which is used to produce the deflection of the magnet. The total amount of power thus transmitted from one place to another is, of course, exceedingly small, but the same principle, applied on a larger scale, effects the transmission of many horse-powers, and it will be my task to show you how this is done in practice.

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* Paper read before the London meeting of the Association of Municipal and County Engineers.

Before entering upon this subject I must explain an expression used, in stating the fundamental principles on which the electric transmission of power is based. I said that we require a coil and a magnet "or its equivalent." The equivalent of a magnet is, as you know, a coil through which a current flows, and the experiments ought therefore also to succeed if instead of the magnet we use such a coil. In practical work we use neither a steel magnet nor a coil alone, but a combination of a coil with an iron core constituting what is known as an electromagnet.

You know that according to our modern conception of magnetic fields, there emanates from each pole of a magnet a certain flow of lines of force; and when we thrust a magnet into a coil we cause the individual wires of the coil to cut through the lines of force. The quicker the movement—that is to say, the more lines of force are cut by each wire in unit time—the greater is the E.M.F. produced; and the more wires are contained in the coil the greater is the E.M.F. produced, since the E.M.F. impulses of the different convolutions are added. It is also easily seen by experiment that the stronger the magnet the greater will be the E.M.F.; so that we find that the E.M.F. is proportional to the product of strength of field, speed of cutting, and length of conductor. Denoting these quantities respectively by H, v, and l, the E.M.F. produced is in C.G.S. units $H v l$, and remembering that a hundred million C.G.S. units of E.M.F. are equivalent to one volt, we have the E.M.F. in volts given by the expression

$$\text{Volts} = H v l \, 10^{-8},$$

In this formula the strength of field is given in lines per square centimetre and speed and length are given in centimetres.

The mechanical force experienced by a conductor in the neighbourhood of a magnet pole is, according to our modern views, due to the fact that the conductor is laid across the lines of force emanating from the magnet pole. The force in dynes is given by the product, $H c l$, c being the current. Since there are 981,000 dynes required to represent the force of one kilogramme, and since the C.G.S. unit of current is 10 amperes, we have the force produced by a current of c amperes—

$$\text{Kilogrammes} = \frac{H c l}{9{,}810{,}000}$$

These are the two fundamental equations required in the design of plant for the electric transmission of power. Now let us see what is the most simple kind of plant we could possibly employ. At the generating station we require a conductor cutting lines of force; this conductor must be joined by wires with a similar conductor at the receiving station. The second conductor is also laid across lines of force, so that when a current passes it will be acted upon by a mechanical force displacing it parallel to itself and doing work. The arrangement here described is shown in Fig. 1, where the lines R represent fixed, horizontal, parallel rails, across which are laid sliding rails or sliders, S_1 S_2. Imagine the magnetic lines of force passing vertically between the fixed rails, then, if we displace the slider, S_1, an E.M.F. will be set up in it, causing a current to flow through the connecting wires, W, and the slider, S_2, at the receiving station. The slider, S_2, is supposed to be laid across lines of force, and will, therefore, be acted upon by a mechanical force. Thus, power may be electrically transmitted from the slider S_1 to the slider S_2. It will immediately occur to you that the experiment I have here illustrated could easily be tried by means of any railway. The fixed conductors and connecting wires would be the rails; the generating slider would be a crowbar thrown across them, and hauled along by a train; and the lines of force would be supplied by the vertical component of terrestrial magnetism. At another part of the railway—possibly miles away—another crowbar thrown across the rails should then be set in motion by the current passing through it. Theoretically, such an arrangement represents correctly enough the electric transmission of power; but I need hardly tell you that it would not work in practice. If you apply the E.M.F. formula I have given to this case, you will find that even if the slider is hauled along at the speed of an express train, there will only be generated about the one-thousandth part of a volt, the reason being that the magnetic field provided for us by nature is so extremely weak. If we could apply an artificial magnetic field of the strength generally employed in dynamo machines—that is, about 10,000 times as strong as the vertical component of terrestrial magnetism—then we could get about 10 volts in our slider. Now, it is obvious that we cannot spread so strong a field over miles of railway, and we must therefore alter our arrangement. This may be done as indicated in Fig. 2, where one of the rails has been replaced by a centre contact, and the other by a circular conductor. The slider, instead of being moved parallel to itself, must now revolve round the centre contact, which can easily be done by a belt and pulley. We have thus arrived at what is known as a non-polar dynamo. But even this arrangement, although very much better than the progressive slider, is not of practical value for power transmission, because the E.M.F. of non-polar dynamos is still too low. It is only a few volts, whereas we require hundreds, or even thousands, of volts to carry the current to any distance. The obvious remedy is to use a large number of revolving sliders, so connected that the E.M.F. generated in each shall be added; in other words, instead of a non-polar dynamo, we must use an ordinary continuous-current dynamo, wound for high E.M.F. This arrangement is shown in Fig. 3, where G_1 is the generator and G_2 the motor or receiving dynamo. If you connect their brushes, as show in the diagram, and rotate the armature of the generator, a current flows through it, the line wire, W, and through the armature of the motor, and exerts upon the latter a mechanical force, tending to produce rotation and give off mechanical power. I am able to show you this experimentally, by means of two dynamos connected, as shown in Fig. 3.

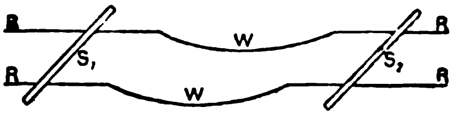

Fig. 1.

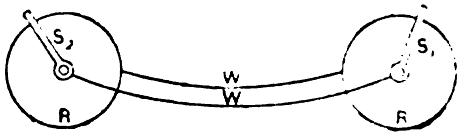

Fig. 2.

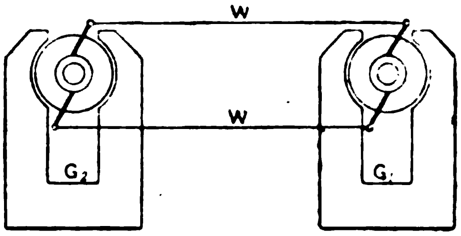

Fig. 3.

The Machines Employed in Power Transmission.

This experiment has shown how power may be transmitted electrically. Let us now consider somewhat more in detail the different parts of the transmitting plant. At one end of the line of transmission we have the generating dynamo, at the other we have the motor dynamo, and then we have the line itself, consisting of two wires insulated from each other and from earth. You will readily see that although for the convenience of experimental illustration I have placed the generator and motor close together, this proximity was not an essential condition of the experiment. The motor might have been placed in another room, or in a different part of London, and still the experiment would have succeeded, provided I had used sufficiently stout and well-insulated connecting wires. But then you could not have had ocular demonstration of the fact that movement of the generator armature is closely followed by a corresponding movement of the motor armature.

A full treatment of my subject would of course include a complete investigation of the dynamo, but this I shall not attempt. In the first place there is no time for it, and in the second place it is hardly necessary, since you are all more or less acquainted with these machines. I shall, therefore, not occupy time by giving mathematical proofs for the few formulæ therefore will survive all others, and are increasing in number slowly but surely. He told me of a great electric railway projected in Russia, some hundreds of miles long, the plans and estimates for which were then before the Czar and his advisers. Also of one which he believed would be gone on between Vienna and Buda-Pesth. European engineers, he said, believed in electricity as a motive power, and financiers were beginning also to believe in it.

Italy is a country we are accustomed to consider as being very poor. I was therefore much struck at the magnitude of the engineering works I saw there. I landed at Brindisi, and travelled by rail thence to Naples *viâ* Torento—for about half the distance among the Appenine range of mountains. The railway was for many miles cut through mountains and over great gorges. The train passed out of tunnel after tunnel, joined together by great bridges built over the gorges. I am sure we in this country would not attempt to build such a railway; we would consider its cost prohibitive.

In Rome I found one of the finest electric lighting stations in the world. Money lavished to make everything about it as good as it could be. Indeed, the idea in my mind was that the gas company, to whom it belonged, had a desire to show how expensive electric lighting was. I found, however, that the gas company was so satisfied with the electric lighting that they were arranging for a very much larger station at Tivoli, where is a great water power to be utilised to drive dynamo machines, the current to be carried underground to Rome. In Rome, too, the city authorities were engaged in engineering works; making new streets, and otherwise beautifying, making more convenient and more healthful, and transforming that ancient and eternal city into a modern one.

In other Italian cities I found the same signs of engineering activity, which seemed to me wonderful considering the immense sums of money spent yearly upon naval and military works, and the fact that the immense standing army maintained not only cost so much to maintain, but took so many thousands of men from the ranks of producers.

In America, electricity is everywhere. Every little town has its central station. Arc lamps are to be seen in all the streets, and incandescent lamps in the buildings. Electric trams, too, are very frequent. The mileage of the different kinds of street railways in September of last year was: Horse, 6,043 miles; electric, 2,065 miles; and cable, 501 miles. And day by day the horse systems were, and are being changed to electrical.

In Albany, the State city of New York, I rode in an electric tram which travelled at 12 miles an hour. One part of the route was round a hill, where the curve was considerable, and the gradient 1 in 15. When in New York I met a large number of electrical men from all parts of America. They had come to New York to attend a meeting which is held half-yearly, and at which all kinds of electrical applications are discussed. They all laughed at the idea of any kind of power competing successfully with electricity for all short railways, and even agreed that 10 years would see it applied also on long lines. The use of electricity had given an impetus to underground railways in large cities. New York and Chicago are now seriously contemplating taking their street railways underground. I saw a sketch of one designed for Chicago. Four lines were to be laid, each in a separate tunnel, two to be for an express system and the other two at every street corner.

It is curious when thinking of underground and electrical railways to note that in the *Illustrated London News* of November 10th, 1855, there is a description of a proposed railway to connect England and the Continent under the Straits of Dover, the rails to be laid in iron tubes, the motive power of the railway to be electricity, and the tunnel to be lighted by the same medium.

In America whenever a motive power is wanted electricity is thought of. In mining to transmit power from the top to the bottom of shafts, to crush, haul, and pump, and propel trucks, to break down the products by electrical drills and miners, to light—indeed, to do everything. Fancy a great central plant, dynamos driven by immense engines constructed and worked on the most economical principles, wires led from the dynamos all over the town at any voltage desired, the current transformed at convenient places, and then led about to light the streets and houses, and drive the many kinds of machinery used, not only for propelling tramcars, but driving saws, sewing machines, hair brushes, and the other hundreds of different kinds used in a big city.

I think one of the chief reasons why electrical applications are so popular in America is the fact that they are so much discussed both by journals, and at meetings of societies, "conventions," as they are called. There are very many associations, the members of which meet at more or less frequent intervals, discuss subjects of interest, and have excursions together, and afterwards disseminate in their several centres the information they had gained. People, ladies as well as men, come from all parts of the United States and Canada to attend these meetings, and it is surprising the wide interest taken in them.

At one the following were among the papers read: On Electric Power Tables and Curves, On Primary Batteries, On Photo-Electricity, The Electric Arc, Distribution of Steam from Central Electric Light Stations, Electric Light as used on Railroads, Electric Light Wiring from a Mechanical Standpoint, Underground Conduits, Care of Alternating Currents, Electric Measuring Instruments, Rating the Candle-power of Incandescent Lamps.

I meant to speak of several other electrical matters of interest, including the supply question when using currents of high pressure, the use of transformers, electric meters, and the construction of incandescent lamps, but my notes have already become so long that I must defer doing so to some future occasion, and will conclude by telling you of a visit I paid to a laundry in one of the American cities. I was leaving the next morning, and was told that our washing, the accumulation of two or three weeks, which had been sent out the day before was not yet returned. After making certain enquiries I found that the most sure way to get my shirts, etc., was to go to the laundry for them, which I did accordingly. I found that all the machinery was driven by an electric motor, taking current from the street mains—washing machines, mangling machines, and even ironing machines were electrically worked. The last were in operation and most interested me. They consisted of two hollow cylinders of iron kept hot by means of spirals of wire passing through the inside and which were maintained at a red heat by electric currents. The cylinders rotated slowly, and were kept together by means of spring pressure. Collars were being ironed by being passed twice between the rollers, and the process seemed to answer admirably.

I got my clothes, and had the satisfaction of knowing that if I had not visited the laundry I would have missed seeing the electrical ironing machines, and also would have been detained in the city at considerable inconvenience, or gone away without my shirts.

COMPANIES' MEETINGS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY

The eighth annual meeting of this Company was held at the Westminster Palace Hotel on Tuesday, the chairman (Mr. J. Staats Forbes) presiding.

The **Secretary** (Major Flood Page) having read the notice convening the meeting, and the report (which with the balance-sheet will be found in our last issue) having been taken as read,

The **Chairman** said: I don't know whether any gentleman has gone through the agreeable exercise I have within the last 24 hours, of reading all the reports from the beginning—that is, in 1884, when the Company began business? We are now dealing with the eighth complete year of the undertaking. I discovered a very singular thing—viz., that all the early reports are what is called very full; there are a great many paragraphs, and they are very long. I have been conversant with the reports of different companies for a good many years, and I find this the characteristic of all these reports—where the dividends are short the report is very long, and *vice versâ*. This seems to indicate that when the company has emerged, as we have done, from mere preliminary difficulties and trials, there is very little to say. It is your acts, not your words, which help you then. How much profit has been made? Well, happily for us, our reports have gradually diminished in length almost as the dividends increased in amount, and this report which is before you to-day is one of the shortest we have ever had, and I hope you think as we do, that it is one of the most satisfactory, because it reveals one or two primary things of some importance—viz., the bulk of the business has increased, and the profit has increased, and we are, happily, enabled to dispense in respect of the year, and of arrears accruing due to the A shareholders, a larger amount than last year or in any preceding year. That is the whole of the story. As I said last year, this class of business—of paying large dividends—is rather a novelty to me, and I have been an apologist for so many reports that I am rather nonplussed when there is nothing to say. The whole story lies in the figures. These joint stock company accounts are not quite so full as those I am in the habit of dealing with, but the essence of them lies in the profit and loss account. Take the first account. On the one side you will see there is income, on the other side the cost of attaining it. I propose to take you through the income in order to compare the year with which we are dealing with the preceding one. Now, take sale of lamps, fittings, royalty on holders, etc., £143,229. 14s. 11d. The corresponding heading last year revealed £118,865. 15s., so that the amount of sales has increased by £24,363. 19s. 10d. The next item is interest, etc., £427. 12s., against £1,442 in the preceding year, a diminution of £1,000 or more, arising from the fact that in the course of the year we realised the bonds of a certain company which paid 4 per cent. interest until we took them over and converted them into money, and of course that affected us. Another item of income is stock on hand. I have had to explain a great many times that we are bound in the very nature of the thing to keep a very large amount of money locked up in stock. There are one or two great types of lamps, the 16 c.p. and some smaller ones, which constitute the mass of our business. But there are a great many lamps of other types, and these are themselves subdivided into types of more or less power, which involves this, that in order to suit the necessities of a great many customers, and the varying conditions of some of them, we are obliged to keep a large supply of lamps on hand or on call. Take this time of the year; these are two of the slackest months of lighting, June and July, but we must have sufficient provision put ready for the darker days of winter. It would not do to postpone the manufacture of lamps until they were wanted. You see what that means. The stocks last year were £56,266, this year they are £59,308. That is a large amount of money to have locked up in any business. I must qualify the amount, however, by saying that a considerable portion of it is not represented by lamps at all, but platinum. We secured a large quantity of it, as I told you last year, at a price which was subsequently greatly exceeded in the market; but we had to find the money for it, and it goes into stock. We have now £15,000 worth of it, and we have a great quantity of manufacturing material which must be in store from time to time.

On the opposite side of the account you will see what the cost of production has been. Dealing with the stock in hand at 1st July, 1890, diversity of lamps and many different makes at very varying prices, but it is not to our interest to reveal the price of any particular one.

Mr. Hedges remarked on the difficulty he had in dealing with his Swan United shares. He thought they ought to face this matter. Couldn't they get a quotation on the Stock Exchange for them?

The **Chairman** explained that the difficulty with regard to these shares arose from the Edison having been launched into the undertaking under very different circumstances to the Swan. The Swan Company had foreign patents and they kept them up, and the difficulty was that they held the major portion of the shares in this Company, but could not distribute. The Beard had tried to arrange the matter, but so far unsuccessfully; it must be dealt with by negotiation.

In reply to another shareholder the **Chairman** explained that they had retained the absolute right to manufacture and sell lamps, and they did this in preference to licensing other makers. But with regard to holders, the same reasons against licensing did not hold good, and they had licensed some eminent firms to make holders.

Replying to a further question and suggestion the **Chairman** said that they had gone on the theory of making things safe. He remembered a time when matters were not quite so pleasant as they were now. The Board desired to safeguard the proprietors. He then put the resolution adopting the report, which was carried unanimously.

The next resolution, moved by the **Chairman**, was the declaration of the three different dividends (*vide* report), which was seconded by **Mr. F. R. Leyland** and carried unanimously.

Mr. Forbes then vacated the chair, and his re-election was moved by **Mr. Leyland**, in eulogistic terms, seconded by **Viscount Anson**, and carried *nem. dis.*

Mr. Leyland was then unanimously re-elected a director on the proposition of **Mr. Forbes**, seconded by **Mr. E. Villiers**.

The re-election of the auditors, Messrs. Welton, Jones, and Co., concluded the proceedings.

DIRECT UNITED STATES CABLE COMPANY.

The twenty-eighth ordinary general meeting of this Company was held on Friday, 17th inst., at Winchester House, Sir J. Pender presiding.

The **Chairman** stated that the revenue for the half-year ended the 30th ult., after deducting out-payments, had been £37,353, and the working and other expenses, including income tax, but exclusive of the cost of repairs, had been £18,113, leaving a balance of £19,240 as the net profit of the half-year, which was increased by the amount brought forward to £24,750. An interim dividend of 3s. 6d. a share for the quarter ended March 31 had been paid, and they now proposed a final dividend of 3s. 6d. a share for the quarter ended the 30th ult., leaving £3,502 to be carried forward. The revenue had shown a falling off of £2,664 as compared with that of the corresponding period of 1890, owing to slackness of business, to some curtailment of trade in consequence of recent fiscal arrangements of the United States Government, and to the temporary loss of traffic with the West Coast of South America through the war in Chili. The investments, which had been increased from £234,993 to £244,652, were entered in the balance-sheet at cost, which was a figure considerably below their present market value. He wished that their prospects enabled him to say that they might soon return to the dividend of 5 per cent. which used to be paid by that Company; but he reminded them that at that time there were only six Atlantic cables, whereas since then another cable had been laid by the Western Union Company, while two more had been put down by the Commercial Company. Since their last meeting the French Courts had, he believed, decided the suit they were engaged in in the English company's favour. He did not, however, wish them to be too sanguine about the money which they might get as the result of the decision.

The report was adopted, and the dividend declared.

COMPANIES' REPORTS.

CROMPTON AND CO., LIMITED.

Directors: H. H. J. W. Drummond, Esq., Bernard Gibson, Esq., Viscount Emlyn, Carleton F. Tufnell, Esq., and Rookes Evelyn Bell Crompton, Esq., and John Francis Albright, Esq. (managing directors).

Third report of the Directors to be presented at the annual general meeting at the City Terminus Hotel, on Wednesday, the 29th July, at 2.30 p.m.

The Directors beg to submit to the shareholders the third annual statement of accounts and balance-sheet made up to the 31st March last. The business of the Company continues to increase, the order-book is well filled, and negotiations are on foot for several important central station contracts, in addition to those at present in hand. The Directors have given considerable attention to improved arrangements at the Chelmsford works for increasing the output, so as to ensure punctuality in the execution of orders. The fitting up of the London works, referred to in the Chairman's speech at the general meeting last year, has also been completed. These alterations and additions have entailed a rather heavy outlay on capital account. Mr. F. Albright, one of the managing directors, has been on an extensive tour through Canada, the United States, Australia, India, and the Cape, visiting the different agents of the Company, and making arrangements which, it is hoped, will lead to a considerable extension of the Company's business abroad. The date appointed for the meeting of the shareholders has been delayed, to allow for Mr. Albright's attendance on his return to England. The net profits of the year amount to £13,030. 14s. 7d., and after providing for the debenture interest and other payments set out in the revenue accounts, and deducting the interim dividends already paid on both the preference and ordinary shares, there remains, with the £474. 18s. 10d. brought forward from last year, a balance available for dividend of £6,484. 18s. 10d. The Directors propose, after setting aside a sum of £500 as a provision for doubtful debts and contingencies, to declare a dividend of 3s. 6d. per share, making 7 per cent. per annum upon the preference shares, and 5s. 6d. per share—making, with the interim dividend, a total of 8 per cent. per annum—upon the ordinary shares, carrying the balance forward. Sir Charles Grant has retired from the Board, and the Directors have elected Mr. H. H. J. W. Drummond and Viscount Emlyn to fill this vacancy and that caused by the death of Viscount Torrington, mentioned last year. In accordance with the articles of association, Mr. B. Gibson retires from the Board of Directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election.

STATEMENT OF LIABILITIES AND ASSETS AT 31ST MARCH, 1891.

Capital and Liabilities.

Dr.	£	s.	d.	£	s.	d.
Authorised issue 28,000 shares at £5	140,000	0	0			
Ordinary shares, 8,000 issued as fully paid	40,000	0	0			
Preference shares, 20,000 at £5 ...	100,000	0	0			
				140,000	0	0
Debentures issued				31,050	0	0
Loan from bankers				10,000	0	0
Sundry creditors				31,317	13	2
Doubtful debts and contingencies account				464	13	5
Reserve fund				568	0	0
Revenue account balance				6,484	18	10
				£219,885	5	5

Cr. *Property and Assets.*	£	s.	d.
Freehold property and ground rents	19,309	2	1
Stock-in-trade, plant, tools, furniture, fixtures, etc.	66,903	2	9
Installations (including balance of working account to March 31)	13,265	5	7
Trade debtors	47,299	19	9
Investments in shares of other companies	16,751	0	0
Loans at interest to subsidiary companies	6,905	8	11
Cash at bankers and in office	8,941	6	4
Preliminary expenses—suspense account	500	0	0
Patents account	10,010	0	0
Goodwill	30,000	0	0
	£219,885	5	5

PROFIT AND LOSS ACCOUNT FOR YEAR ENDING 31ST MARCH, 1891.

Dr.	£	s.	d.
Trading and office expenses, salaries, agencies, etc.	17,058	3	0
Repairs to buildings and plant	1,532	11	8
Depreciation of plant and machinery, patents, and fixtures	2,087	4	7
Balance carried to revenue account	13,030	14	7
	£33,708	13	10

Cr.	£	s.	d.
Gross profit and trading account, pupils' premiums, profits and dividends on investments	33,708	13	10
	£33,708	13	10

Dr. REVENUE ACCOUNT.				£	s.	d.
Interest on debentures and mortgages				1,019	5	5
Preliminary expenses (written off)				338	5	0
Directors', trustees', and auditors' fees				1,111	11	4
Interim preference dividend paid December, 1890	3,406	5	4			
Interim ordinary dividend paid February, 1891	975	0	0			
Income tax	170	7	6			
Balance available for present distribution	6,484	18	10			
				11,036	11	8
				£13,505	13	5

Cr.	£	s.	d.
Balance from last year	474	18	10
Net profit from profit and loss account	13,030	14	7
	£13,505	13	5

GLOBE TELEGRAPH AND TRUST COMPANY.

The report of the Directors for the year ending July 18th, 1891, states that the net revenue of the Company, after deduction of expenses, amounts to £201,699, which, with the balance brought

NOTES.

The Central London Railway Bill was read a hird time before the House of Lords on Monday and assed.

Spandau.—The Thomson-Houston Company have obained a concession for 50 years for an electric railway at Spandau, near Berlin.

Telephonic Extension.—A supplementary trunk line of the National Telephone Company has been completed his week between Edinburgh and Penicuik.

History of Electricity.—The "Chronological History f Electricity," by P. F. Mottelay, appearing in the *Electrical World* is also being published in *Engineering*.

Eastwood House.—On Monday night Captain Selwyn's new hall, Eastwood House, was opened, and the electric light shone on his house-warming meeting.

Electrical Work in Mines.—Before the South Wales Institute of Engineers last week, Mr. Albion T. Snell read a paper entitled "Notes on Electrical Work in Mines."

Telephones in Holland.—The Chamber of Commerce at Breda, Holland, has expressed its desire that the Dutch Government should buy up the telephone service and work it as a State department.

Rechniewski Dynamos.—We learn that Messrs. E. L. Berry, Harrison, and Co., have been appointed sole agents in England for the Rechniewski dynamo, which earned high praises and a gold medal at the Paris Exhibition.

Hampstead.—A long discussion took place on the question of electric light at the last meeting of the Hampstead Vestry, at which Mr. Preece was specially invited. The discussion and consideration was left over till October.

Sunderland.—At the last meeting of the Sunderland Highways Committee the borough engineer reported that he had received several replies to his enquiries from other towns with regard to the electric light, and the matter was referred to a sub-committee.

Asbestos Goods.—The United Asbestos Company, Limited, has for the seventh time secured the contract for the supply of all kinds of asbestos goods required for use in her Majesty's Navy during the ensuing 12 months, including packing, sheeting, cloth, and millboard.

St. Pancras.—Mr. James T. Baron has been appointed chief engineer and general manager to the St. Pancras Vestry for their central station supply department. Mr. Baron was Mr. Wilson Hartnell's outside general manager, and has had much experience in important work.

Paris Lighting.—At a meeting on the 24th inst. the Paris Municipal Council granted to M. Victor Popp the concession for electric lighting of the Entrepôt de Bercy. The lamp hour of 10 c.p. is fixed at 1·8 centimes or 0·18d. At this price everyone would be able to use the light.

Ventilating.—Messrs. J. D. F. Andrews and Co. have, in conjunction with others, purchased the patents, goodwill, and assets of the D. C. Green Ventilating and Engineering Company, and are now fitting an extensive installation of the D. C. Green system of ventilation on board the s.s. "Ophir."

Trinidad and Tobago Cables.—In the House of Commons, on the 23rd inst., in answer to Admiral Field, Baron H. De Worms said the importance of establishing telegraphic communication with Tobago has not been overlooked, and it is hoped that the revenue of that island may before long be able to bear the cost.

Akester Electric Motor Company.—A meeting of this company was held on Monday at Cannon-street Hotel. The proceedings were private. This company was formed to carry out the patents of Mr. Akester in tramway work, and a car was built some time ago and run experimentally at Messrs. Stephen Smith's works at Millwall.

Phonopore.—Those who wish to investigate the properties of Mr. Langdon-Davies's phonopore will have the opportunity to do so in a pamphlet on the "Phonopore Duplex Telegraph," giving full particulars as to working, with drawings, published (in French and English) at 2s. by the Phonopore Syndicate, Blomfield House, E.C.

Khotinsky Accumulators.—The firm of Betts and Co., of Carcassone, have acquired the French patents of Khotinsky for accumulators. The Khotinsky Company have for eight years made these accumulators with much success. They are similar to the Betts accumulator, and the combination is known as the "Khotinsky-Betts" cell.

Gas v. Electricity.—The North British Association of Gas Managers held their thirtieth annual meeting last week in Edinburgh. The president, Bailie Robertson, in his inaugural address, alluded to the rivalry of electricity, but did not consider it had affected gas interests, nor in any way curtailed the sale of gas. He was inclined to look upon paraffin as a far more serious rival.

Society of Arts.—The Prince of Wales at Marlborough House on Monday presented the gold medal of the Society of Arts to Mr. W. H. Perkin, for his discovery of producing colouring matter from coal tar; and to Sir Frederick Abel, for his researches in the manufacture of iron and steel, and his services to the State with reference to war material, and as chemist to the War Department.

Reigate.—The Reigate Town Council on Tuesday resolved that an application be made to the Board of Trade for a provisional order under the Electric Lighting Acts, and that the Mayor (Mr. S. Brookes) be requested to cause the necessary steps to be taken for the carrying out of this resolution, assisted by the borough engineer, Mr. F. D. Clark, A.M.I.C.E., and the town clerk, Mr. C. J. Grece, LL.D.

Cricket.—The return match between a team got up by the *Electrical Review* and *Electrical Engineer*, and one representing Mr. Ronald Scott's electrical works at Acton, was played in Mr. Scott's grounds on Saturday last. The weather was perfect, and an enjoyable game resulted in a well-deserved win for the Acton team. After the match, the visiting eleven were hospitably entertained by Mr. Scott.

Berlin Gold Medal.—From Berlin it is announced that the large gold medal for science has been conferred upon Prof. Du Bois-Reymond, M.D., F.R.S., member and secretary of the Royal Academy of Sciences in Berlin, and director of the Physiological Institute. The professor is best known for the important services he has rendered to science by his researches in the department of animal electricity.

Literature.—We have received the fourth yearly number of the *Fortschritte der Elektrotechnik*, containing summary of electrical progress of the year, references to important articles in technical papers, and description of the work of Messrs. Siemens and Halske, Schückert and Co., and the Allgemeine Company of Berlin, for the Government

Board should take it into consideration, and see if they could not arrange with the local firm who had already introduced it in Bideford to light the Bideford New Quay.

Colonial Enterprise.—Mr. J. F. Albright, managing director of Crompton and Co., Limited, has just returned after a very successful tour round the world. He started originally with the Iron and Steel Institute for the United States, and then went to Australia to look after the business of the Crompton Electric Supply Company of Australia. After spending some months in various parts of Australia, he went to Ceylon, and from thence to Calcutta. After this he proceeded to Colombo and Mauritius, *en route* for Durban. Making this his headquarters, he went up country to Pretoria, where his company is about to carry out the lighting of the town. We are glad to learn that the change has done him much good.

Permanent Exhibition.—We notice that for some time back there has been established in Paris, in the Passage Jouffroy, a permanent exhibition of electrical appliances, compressed air electric lighting motors, and similar useful facilities of modern civilisation. We should think it might be very well worth while for a few of the larger firms to institute in London, on a modest scale, an exhibition of this nature, with rooms fitted up in every way with electric lighting, heaters, and cookers, with motors applied, and so forth, advertised well in the daily press. The number of people even now who do not realise the benefits of electricity, and do not understand the very rudiments, is still enormous.

Staple Driver.—An extremely simple and cheap, and at the same time effective, little device has been introduced by Messrs. Woodhouse and Rawson in the shape of a patent staple driver for electric or other wires. This tool holds the staple in position until it has penetrated sufficiently far to dispense with further support, and can be driven home with a hammer. It consists of a rectangular tube of the size to hold the staple, inside being a plunger with a movement of about ½in. The points of the staple project, and are placed over the wire, and a blow is given to the opposite end of the plunger, the tool is removed and the staple driven home. It will be especially convenient to the electrical trade for running wires overhead or in corners where the staple cannot be held with the fingers.

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Austrian Telephones. — The concession granted several years ago to the Telephone Company of Austria for opening telephone exchanges in the towns of Gratz, Prague, and Trieste will expire in October this year, and the concession for five other towns, Lemberg, Reichenberg, Pilsen, Czernowitz, and Bielitz, held by the same company, will terminate in February, 1893. The company, which is an English one, has received notice that the concessions will not be renewed, and that the exchanges in all the towns mentioned will be worked by the Imperial Postal Department. It has accordingly demanded compensation to the extent of 1,900,000 florins, or about £160,000 sterling, but the Government object to the amount as exorbitant. The dispute will probably be settled by arbitration, as provided in the terms of the concession.

Andes Railway.—The tunnels of the wonderful railway now in course of construction through the Andes for the purpose of establishing communication between the Argentines and Chili are being bored, it appears, by the aid of the electric current. The highest of the tunnels is about 10,000ft. above sea-level, while the pierced mountain is about 12,000ft. From Juncal, in Chili, to Quebeda Navaro, in the Argentines—a distance of about 14 miles—there are, it is stated, no fewer than eight tunnels, of a total length of nearly 9½ miles. It having been found impracticable to employ steam engines from the great expense of raising machines and fuel to so great an altitude, it was decided to utilise the water power available in the valley for supplying the necessary power; and the great turbines are reported to be doing their work well.

The Paris Metropolitan Railway.—The Paris Municipal Council on Saturday continued the debate on the subject of the proposed metropolitan railway, and heard the evidence of the director of the works, and M. Sauton, the reporter, the latter explaining the views of M. Guyot as regards the rights of the Council in the matter. The Council, without deciding at this stage for any of the schemes before them, declared themselves generally in favour of the construction of a metropolitan railway. A clause in the first article dealing with the course to be followed by the railway was adopted, and a motion introduced by Charles Laurent that the line should in no case follow the boulevards, was also passed by 34 votes against 23. The whole of the first article was then agreed to without amendment, and finally the project was adopted by 60 votes against nine.

Hospital Music by Telephone.—The Rev. Frederick Harford, M.A., minor canon of Westminster, has formed a "Guild of St. Cecilia" for the distribution gratuitously of soft and sweet music for hospital patients. Canon Harford is a great enthusiast upon the well-known soothing effect of dreamy music upon sick persons, variously applied since the time of King Saul, and is organising his guild for the purpose of systematically using music as a healing medicament. His proposal is partly to organise bands of violin performers (with muted violins) and portable "pianino" to perform outside the wards, but he has now extended his idea to include the establishment of a complete system of telephonic distribution from a central hall to the various hospitals. Canon Harford has himself written much suitable music, and already enlisted the sympathy of some influential persons in favour of his scheme.

Gas v. Electric Light in New York.—For 40 years prior to the introduction of electricity for lighting purposes in New York City, the increase in the consumption of gas, says a gas journal, averaged about 10 per cent. per annum, while the population doubled every 17 years. Since the adoption of the electric light, however, the increase has been much more rapid. It almost immediately rose to 12 per cent. per annum, and in 1887 it was equal to about 14 per cent. per annum. This ratio was still further exceeded in 1888-9-90. The output of gas in New York is doubling itself now in a period of 6½ years instead of 10 years. The president of the Standard Gas Company thinks that one reason for this very rapid increase is the fact that the electric light has educated the human eye to require more light, and that people are not satisfied with the quantity they formerly regarded as sufficient.

Contracts.—The following are mentioned as likely contracts for the application of electric light: New hospital at Bradford—J. B. Bailey, architect; Dalton-in-Furness, Co-operative Society premises—J. McIntosh, architect, Barrow; Corn Exchange, Gainsborough—D. Macdonald, borough engineer; Weights and Measures Offices, Leeds—borough engineer, Leeds; Bank at Maryborough (Ireland)—J. O'Callaghan, architect, 16, Nassau-street, Dublin; Workhouse at Newcastle; Academy at Stonehaven for Dunottar Educational Trust; Grammar School, Wakefield, apply headmaster; Court House, Cork—Court House Joint Committee, Cork; Library Buildings, Southampton—(W. Henman, architect), apply librarian, Public Library, Southampton; new Municipal Buildings, Oxford—Mr. Bickerton, town clerk, Oxford; Public Library, Brechin, Scotland—architect, J. M. Fairley, 122, George-street, Edinburgh; Police Station, Glasgow—

works taken from the Ebbw Vale, the Lilleshall, and the Steel Company of Scotland works. The chapters on steel are equally practical; the methods of manufacture are described and compared, and the applications dealt with. Great attention is paid to the question of testing both iron and steel, and much information not otherwise easily attainable is given, as Mr. Skelton has at command full particulars from a large trade experience of the manufacturers', Admiralty, and Board of Trade tests. The work concludes with a score of pages giving a very complete list of the trade sizes of rolled iron and steel, with comparative prices and remarks, and altogether makes one of the most useful books of reference that an engineer could place in his library.

Egremont. — The last monthly meeting of the Egremont Local Board had before them the question of electric light. It being stated that the gas rate would be 4s. per 1,000 cubic feet, a letter was read from Messrs. Nicholson and Jennings stating that the cost of a complete light installation, excepting motive power and house, would be £1,972. 10s. They also asked for information as to the River Eden with a view to it being utilised as motive power. The chairman said it appeared the outlay in adapting the electric light would be very expensive. The clerk said Messrs. Nicholson and Jennings originally fixed the cost at £3,000, but if water were going to be used as the motive power they had reduced it to £1,972. The surveyor stated the gas came to about £300 a year. The gas costs about £200, besides the cost of other work. The view was expressed that there would not be enough water in the river during the summer months. The chairman referred to the installation at Keswick. Mr. Smith stated there was plenty of fall and power—any amount. The chairman thought they ought to be sure of having it all the year round if the public were to have the benefit of it in private houses. Mr. Armstrong thought the tender a remarkably small one. They could borrow £2,000 at 4 per cent. It might be too late in the year to entertain it now; but if the gas company did not give them better terms another year it should be seriously considered. Mr. Stout said there was not the slightest doubt but that they were paying far too much for the gas. Whitehaven had it at 3s. 2d., and the only difference in producing it at Egremont would be the carriage of coal. The chairman said the gas company had laid out a lot of money in putting down the pipes. He did not think they could let them have gas much cheaper. After further discussion, the surveyor was instructed to report upon the subject at the next meeting, and it was agreed to supply the information asked for by Messrs. Nicholson and Jennings.

British Association.—The president-elect of the Cardiff meeting is Dr. William Huggins, F.R.S., one of the most eminent astronomers living, whose spectroscopic researches on the celestial bodies have yielded the most brilliant results. It is probable, then, that Dr. Huggins's presidential address will deal mainly with the work of his life, and he may be expected to review briefly the results which have been achieved by the application of spectroscopic photography to the heavenly bodies. From the president, Prof. O. J. Lodge, F.R.S., of Section A (Mathematics and Physics), something at least original, if not startling, may be expected. It is understood that he proposes to advocate the establishment of a permanent Government physical laboratory on the lines of the Greenwich Observatory to be devoted to physics instead of astronomy; taking up the more serious quantitative determinations, and the observation of molecular changes in the properties of materials. It is proposed to hold in Section A, if possible, in conjunction with Section G, a discussion on "Units and their Nomenclature," having special regard to the new electrical and magnetic units now becoming necessary for practical purposes. The president of Section G (Mechanical Science) is Mr. T. Forster Brown, the well-known engineer, and his address will deal chiefly with mechanical appliances associated with coal mining, and specially with reference to South Wales. The address will have reference to the application of compressed air to mining purposes, electricity in mining operations, and to modern improvements in shipping coal. The following are among papers which have been promised for this section: Messrs. P. W. Willans and M. Robinson, on the Willans engine; Mr. W. Robinson, on a petroleum engine; Mr. E. Vernon, on the Bénier hot-air motor; Mr. R. H. Thorpe, on the Otis electric elevator; Mr. W. H. Preece, on the London and Paris telephone; Mr. A. R. Bennett, on the telephone of the future; Mr. S. Walker, on colliery lamps; Mr. T. Timmis, on electric lighting of trains; Mr. J. E. H. Gordon, on sub-stations.

Telegraphing Across Indian Rivers.—Of several telegraphic lines running from Calcutta to differents parts of India, there are five proceeding almost due east, three of which convey the Burmese traffic, and the other two the Dacca, Chittagong, and neighbouring traffic. The country through which these lines pass is intersected by wide rivers, in which connecting cables are submerged. For instance, the Pudda river, which is seven miles broad near Calcutta, is cabled at two points 12 miles apart; and it often happens that these cables break down while the river is in flood, so that repairs are difficult or dangerous, and a boat service to convey the messages from bank to bank, though practicable, is costly and slow. For some time past, therefore, it has been the practice in such a case to telegraph the message by means of Major Cardew's vibrating sounder through the iron sheathing of the cable instead of the interrupted copper conductor. This innovation is due, says the *Times*, to Mr. W. F. Melhuish, of the Indian telegraph service. Two methods are followed, both of which are quite successful. Either a complete metallic circuit, or "loop," as it is called, is formed by two land lines and two cables, the earth being excluded, or a simple circuit is made of one land line and the broken cable, with the earth as a return wire in the ordinary way. In the latter case, notwithstanding the fact that the iron wire of the cable which form the make-shift conductor are in contact with the water for seven miles across the river, the signals of the Cardew sounder can be read with ease, even when the apparatus is 4in. from the ear. This instrument, which has already been described in our columns, was also tried on the copper conductor of a cable which was completely severed, and the signals managed to pass, either by induction across the break or through the surrounding insulator. It is admirably adapted for telegraph signalling in wild countries or with an army in the field, and, as Indian telegraphists say, "it will work through anything." The method in question has enabled the Indian Telegraph Department to dispose of the local traffic and keep the Burmese lines free for their legitimate business. While upon this subject, we may add that Mr. P. V. Luke, C.I.E., director of telegraphs, Calcutta, is now in England arranging for stores and apparatus to be sent to India, and has contrived a very handy portable field telephone station, consisting of a strong teak box containing a combined receiver and transmitter made in one piece and held by the hand for speaking and listening, together with a call-bell, switch, and two cells of a dry battery. The box is of small dimensions and easily carried in one hand.

the concentration of a plant of greater power at the central station.

Three-Wire System.—By this system, which is too well known to need description here, five-eighths of the weight is economised at the cost of a slight complication. This system is, moreover, applicable as well for a simple distribution as for a distribution by means of feeders.

Instead of leading back to the station the third wire, which serves solely as compensating conductor, we may employ an equalising system of consumption, consisting of two armatures fixed to the same armature, and turning in the same field.

One brush of each armature is connected with the intermediate conductor, while each of the two other brushes communicate with one of the main conductors. It is easily seen that, when the lamps are not absolutely equally distributed on the two circuits, one of the armatures acts to that extent as a motor, and absorbs the current from the circuit which has too few lamps, while the other armature, acting as generator moved by the motor, produces current, and adds it to the circuit which has too many lamps; this effect therefore tends to equalise the current in the two circuits. Systems of four, five, etc., wires can also be easily employed, the intermediary conductors returning to the station.

The lighting district of the Place Clichy, in Paris, is supplied in this manner with five conductors, and with consumption equalisers, to regulate the current in each circuit.

The dimensions of the compensating conductors may vary from zero to a cross-section, equal to that of the outside principal conductors. Taking all the conductors as equal, we find, taking as unity the expenditure in copper for the simple distributive system, the comparative cost to be:

For the three-wire system and 220 volts at the lamps = $\frac{3}{8}$
four „ „ 330 „ „ = $\frac{2}{9}$
five „ „ 440 „ „ = $\frac{5}{32}$

If we allow 10 kg. (22lb.) as the limit of weight of copper to be employed per lamp, we arrive at a radius of:

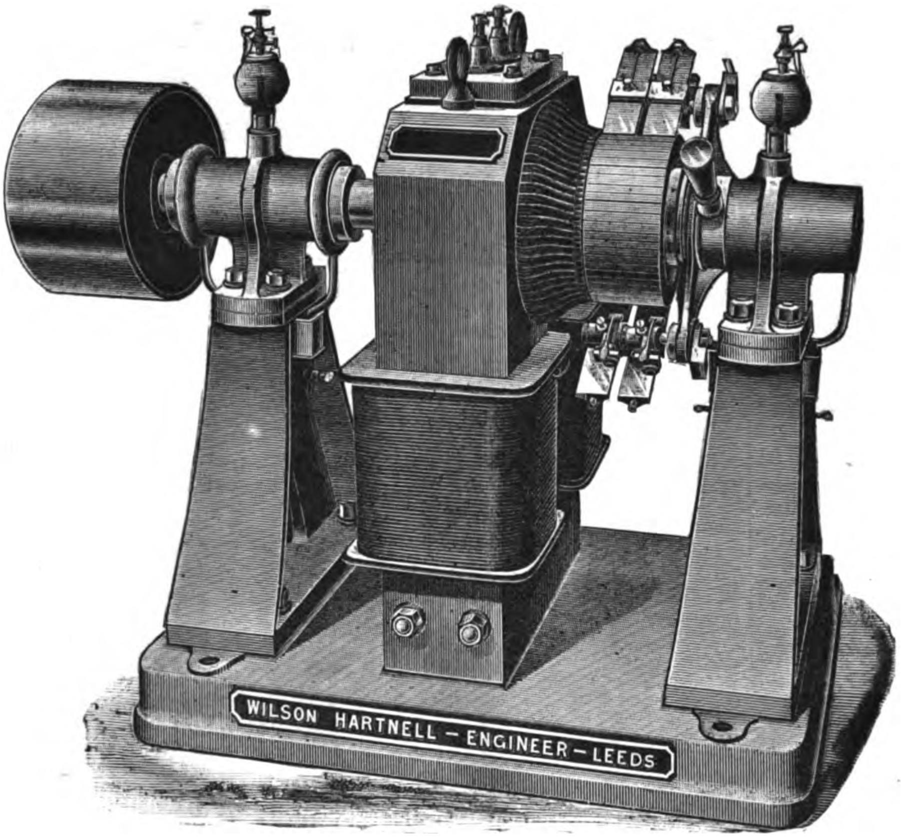
671 metres around the station with the simple parallel system at 110 volts;
1,000 to 1,100 metres with parallel system and ordinary feeders;
1,074 metres with three-wire system;
1,650 to 1,800 metres with three-wire system and feeders;
2,000 to 2,200 metres with five-wire system;
3,300 to 3,600 metres with five-wire system and feeders.

(*To be continued.*)

WILSON HARTNELL DYNAMO.

Mr. Wilson Hartnell, of Volt Works, Leeds, whose name is well known, especially in the North of England, as having carried out some of the largest mill and mansion electric lighting—amongst them Wentworth Castle—has recently taken London offices at 11, Queen Victoria-street, E.C. It may not be yet generally known to our readers that Mr. Hartnell for some little time has been manufacturing his own type of dynamo, and we have recently had the opportunity of inspecting one of the Hartnell dynamos, B type, at the London offices.

The dynamo is well represented in the accompanying illustration. It is a compact, well-finished machine, embodying the latest and best practice in dynamo design, and with some special points of interest. The magnets are of specially annealed wrought iron, and the magnetic circuit is of ample section.



The Wilson Hartnell Dynamo.

The exteriors are finished bright, and give the machine a very smart look. The principal feature, however, is the armature, which is very large for the size of machine, being 8½in. diameter for the B type, which gives 27 amperes at 110 volts for 1,150 revolutions. The spindle is of steel 1$\frac{7}{16}$in. diameter, and the bearings very long and solid—at the pulley end 6in. long, at the other end 4in. long. They are provided with double oil vessels and oil outlet. The commutator is correspondingly large and solid, being 7in. diameter. This large size makes the machine run very cool and free from sparking, and in practice they show no appreciable wear.

The brushes are arranged on a special carrier, designed by Mr. Hartnell, in which a strong spring is released by a trigger arrangement, and the brushes pressed into position. The same trigger takes off the brushes by an ingenious reverse action.

These dynamos are being manufactured at Volt Works, Leeds, and Mr. Hartnell is ready to supply the trade or colonies. Their qualities for continuous running, by

As far as we are aware, all efforts made to solve the problem which we are now considering have hitherto resulted in ailure; but very recently an apparatus has been patented y the Actien Gesellschaft Mix and Genest Company, of Berlin, which they claim, with some show of reason, to ulfil all the conditions necessary for its complete and effecual solution. A short description of the construction and working of the machine, which is described by its inventors s an "automatic call-box," and which is represented in levation at Fig. 1, and opened to show internal arrangements at Fig. 2, may be interesting.

Upon a coin being inserted into the slot, it first passes hrough the usual arrangement for testing with regard to iameter, thickness, and weight. Should it fail to pass the est, it is rejected, but if it proves satisfactory, it passes to pair of grooves, which are movable upon a hinge. Here ts progress is arrested by the upper of three wheel egments, which, protruding into the side of the grooves nd actuated by the armature of an electromagnet, form a heck arrangement. Just before reaching this point, the oin has pressed a small projecting lever, thus making ontact and allowing bell to be rung, when the black knob n front of telephone instrument is pressed. The call is nswered in the ordinary way from the central exchange, nd if the customer is informed that for any reason the required communication cannot be obtained, he has only to press the white stud, when the movable grooves are thrown forward, releasing the coin from the check arrangement, and allowing it to fall to the refunding box.

Should, however, the desired connection be made at the exchange, the current passes through the electromagnet, attracting the armature with a force sufficient to overcome that exerted by its own spring. The coin thereupon falls to the fixed pair of grooves, and is arrested by a segment. Here it remains until the signal at close of conversation is given, when it is again released by the magnet and allowed to fall into the cash-box, pressing *en route* a second lever which, being connected diagonally with it, replaces same, and at the same time breaks contact. This second lever is of such a length that the coin passing to the refunding box presses it, replacing the first lever and breaking contact as if at close of conversation.

Should, however, the closing signal be omitted, it is obvious that the coin will remain in position. In order to prevent loss from this cause a lever, connected at one end to the armature, and terminated at the other by a small roller, projecting into a slot, is provided. By this means the armature is moved, as if electrically, upon insertion of the next coin, and the one remaining in the instrument has fallen into the cash-box before the other has passed through the testing arrangement.

To sum up the advantages claimed for this instrument:

(1) The exchange can only be rung up upon the insertion of a particular coin, connection being thereupon automatically made for the purpose.

(2) The money is refunded if the desired communication is not to be obtained.

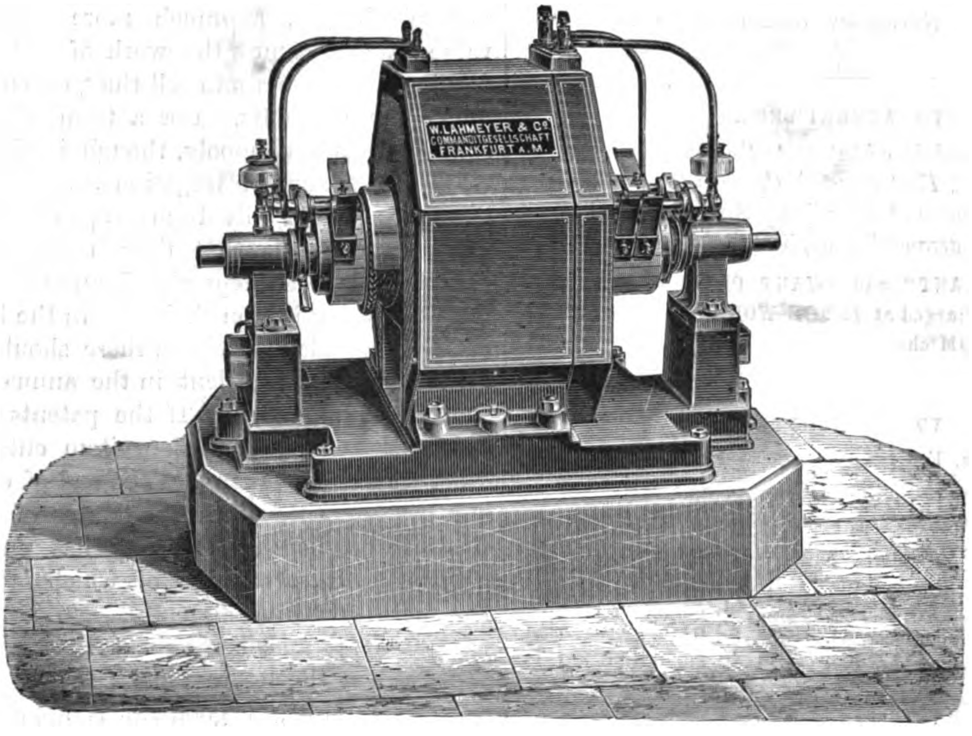
(3) The line is automatically interrupted upon close of conversation.

(4) Absolute security against loss, either on the part of the company or of the customers, no tampering or failure being possible.

The apparatus is now being tested by several European Governments and telephone companies, and after the expiry of the Edison patent it will be shown at the London depôt of Messrs. Mix and Genest, 34, Aldermanbury, E.C., in actual operation.

LAHMEYER DYNAMOS.

We illustrate herewith the continuous-current dynamo of Messrs. Lahmeyer and Co., of Frankfort. The Lahmeyer dynamo is a compact and neat form of machine which has achieved great popularity in Germany. Messrs. Lahmeyer and Co. are also the makers of the Haselwander rotary-current dynamo, an article upon which appears elsewhere. Both machines are exhibited in the Frankfort Exhibition.



Lahmeyer Continuous-Current Dynamo.

TELEPHONE COMPANY OF AUSTRIA.

The eighth ordinary meeting of this Company was held yesterday (Thursday) afternoon at the offices, Mr. Henry Grewing, chairman, presiding. The report shows a total to credit of profit and loss account of £4,485. 18s. 9d., after paying debenture interest and interest on preference shares. In view of the expiration of the Company's concessions in October next, and the action of the Austrian Government, the Board do not recommend the payment of a dividend on the ordinary shares at present. With reference to the Company's concessions, the Chairman stated that the particulars forwarded to a daily paper, and given in one of our notes this week, were so accurate they must have been derived from official sources. The Company were ably represented in Vienna by Dr. Eugen Weissel and Mr. Krause. Some of the Directors had already visited Vienna, and others were about to do so again, to try and secure better and more equitable terms from the Government. The Board had hopes of succeeding in this. The report and accounts were unanimously adopted.

obvious that in the experiment described the ball should not be taken too large.

In consequence of this twofold tendency it is possible to produce by means of points effects identical to those produced by capacity. Thus, for instance, by attaching to one terminal of the coil a small length of soiled wire, presenting many points and offering great facility to escape, the potential of the coil may be raised to the same value as by attaching to the terminal a polished ball of a surface many times greater than that of the wire.

An interesting experiment, showing the effect of the points, may be performed in the following manner: Attach to one of the terminals of the coil a cotton-covered wire about 2ft. in length, and adjust the conditions so that streams issue from the wire. In this experiment the primary coil should be preferably placed so that it extends only about half way into the secondary coil. Now touch the free terminal of the secondary with a conducting object held in the hand, or else connect it to an insulated body of some size. In this manner the potential on the wire may be enormously raised. The effect of this will be to either increase, or to diminish, the streams. If they increase, the wire is too short; if they diminish, it is too long. By adjusting the length of the wire, a point is found where the touching of the other terminal does not at all affect the streams. In this case the rise of potential is exactly counteracted by the drop through the coil. It will be observed that small lengths of wire produce considerable difference in the magnitude and luminosity of the streams. The primary coil is placed sidewise for two reasons: first, to increase the potential at the wire, and, second, to increase the drop through the coil. The sensitiveness is thus augmented.

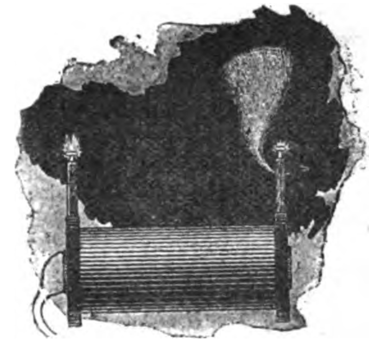


FIG. 13.

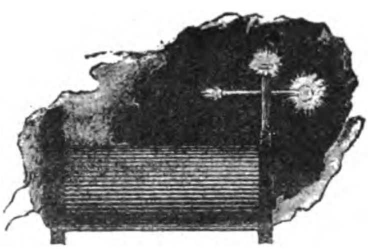


FIG. 14.

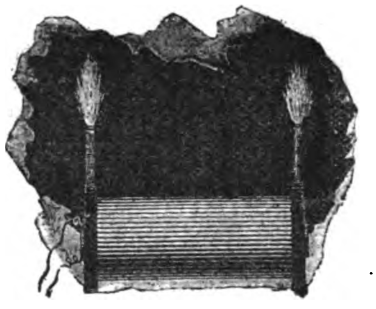


FIG. 15.

There is still another and far more striking peculiarity of the brush discharge produced by very rapidly alternating currents. To observe this it is best to replace the usual terminals of the coil by two metal columns insulated with a good thickness of ebonite. It is also well to close all fissures and cracks with wax so that the brushes cannot form anywhere except at the tops of the columns. If the conditions are carefully adjusted—which, of course, must be left to the skill of the experimenter—so that the potential rises to an enormous value, one may produce two powerful brushes several inches long, nearly white at their roots, which in the dark bear a striking resemblance to two flames of a gas escaping under pressure, Fig. 15. But they do not only resemble, they are veritable flames, for they are hot. Certainly they are not as hot as a gas burner, but they would be so if the frequency and the potential would be sufficiently high. Produced with, say, 20,000 alternations per second, the heat is easily perceptible, even if the potential is not excessively high. The heat developed is, of course, due to the impact of the air molecules against the terminals and against each other. As at the ordinary pressures the mean free path is excessively small, it is possible that in spite of the enormous initial speed imparted to each molecule upon coming in contact with the terminal, its progress, by collision with other molecules, is retarded to such an extent that it does not get away far from the terminal, but may strike the same many times in succession. The higher the frequency, the less the molecule is able to get away, and this the more so, as for a given effect the potential required is smaller; and a frequency is conceivable, perhaps even obtainable, at which practically the same molecules would strike the terminal. Under such conditions the exchange of the molecules would be very slow, and the heat produced at, and very near, the terminal would be excessive. But if the frequency would go on increasing constantly, the heat produced would begin to diminish for obvious reasons. In the positive brush of a static machine the exchange of the molecules is very rapid, the stream is constantly of one direction, and there are fewer collisions, hence the heating effect must be very small. Anything that impairs the facility of exchange tends to increase the local heat produced. Thus, if a bulb be held over the terminal of the coil so as to enclose the brush, the air contained in the bulb is very quickly brought to a high temperature. If a glass tube be held over the brush so as to allow the draught to carry the brush upwards, scorching hot air escapes at the top of the tube. Anything held within the brush is of course rapidly heated, and the possibility of using such heating effects suggests itself.

When contemplating this singular phenomenon of the hot brush, we cannot help being convinced that a similar process must take place in the ordinary flame, and it seems strange that after all these centuries past of familiarity with the flame, now, in this era of electric lighting and heating, we are finally led to recognise that since time immemorial we have, after all, always had "electric light and heat" at our disposal. It is also of no little interest to contemplate that we have a possible way of producing—by other than chemical means—a veritable flame, which would give light and heat without any material being consumed, without any chemical process taking place, and to accomplish this, we only need to perfect methods of producing enormous frequencies and potentials. I have no doubt that if the potential could be made to alternate with sufficient rapidity and power, the brush formed at the end of a wire would lose its electrical characteristics and would become flame-like. The flame must be due to electrostatic molecular action.

This phenomena now explains in a manner which can hardly be doubted the frequent accidents occurring in storms. It is well known that objects are often set on fire without the lightning striking them. We shall presently see how this can happen. On a nail in a roof, for instance, or on a projection of any kind, more or less conducting, or rendered so by dampness, a powerful brush may appear. If the lightning strikes somewhere in the neighbourhood, the enormous potential may be made to alternate or fluctuate perhaps many million times a second. The air molecules are violently attracted and repelled, and by their impact produce such a powerful heating effect that a fire is started. It is conceivable that a ship at sea may, in this manner, catch fire at many points at once. When we consider that even with the comparatively low frequencies obtained from a dynamo machine, and with potentials of no more than 100,000 or 200,000 volts, the heating effects are considerable, we may imagine how much more powerful they must be with frequencies and potentials many times greater, and the above explanation seems, to say the least, very probable. Similar explanations may have been suggested, but I am not aware that, up to present, the heating effects of a brush produced by a rapidly alternating potential have been experimentally demonstrated, at least not to such a remarkable degree.

(To be continued.)

promoting the working of the men's sick clubs. I shall have great pleasure in answering any questions from shareholders present. I conclude by moving the resolution mentioned above—viz., that the report and accounts be received and adopted. Mr. Albright, who has had a long business tour round the world, returned home two days ago, and will give you a statement as to the results of his journey.

The resolution was seconded by **Mr. Carleton F. Tufnell**, and carried unanimously.

The **Chairman** moved the payment of the dividends on the preference and ordinary shares, which was carried. He then informed the shareholders that since the last meeting they had lost a very valuable director in the person of Sir Charles Grant, who, owing to his no longer residing in London, had regretfully given up his directorship. The Board had appointed Mr. H. H. J. W. Drummond, who had served some time and proved of valuable assistance to them. Quite recently they had secured the services of another extremely valuable director, Viscount Emlyn, who was on the Board of the Great Western Railway. The acquisition of this gentleman gave them very great strength, and he was experienced in the management of large bodies of men. His railway connection could not fail to be of value in forwarding the cause of the Company, while he had very greatly increased their influence in the West of England. He moved the approval and confirmation of the appointment of these Directors.

This was seconded by **Mr. G. S. Albright**, and carried unanimously.

Mr. Gibson, the retiring director, having been re-elected,

Mr. J. F. Albright said that he had been alluded to as having just returned from an extended trip round the world, and though he had not had time to think out any elaborate statement of his travels, he would, in a few words, give them a general impression of what he had seen. He first visited Canada, and met there the agents they had recently appointed. He had every reason to be satisfied with the agents, and he believed that the orders they had sent home since his visit had been of considerable importance. He also visited the United States, but, as they were probably aware, owing to the extremely high tariffs, it was almost impossible to do any business there, although they were doing a certain amount. After that he went to Australia and saw their Company which had been established there. His impression of the country, and the way in which it was being worked, was that, although there were many things to be improved upon, still they were better represented than any other English or European firm; probably only one firm was in a better position than they were, and that was an American one. Of course, in Australia the prospect of business was considerable, but, at the same time, it could only be done by people who knew the country well and were well known in the country; and that was one reason why they might consider they were well represented there—the people were old-established residents. He was only a short time in India, but he arranged for their being represented by an old-established house in Calcutta—the oldest house there, and also one that had done more electrical work than any other. From India he went to the Mauritius. Here there was no work left to be done, and no money to pay for any. Leaving the Mauritius he next went to Natal, and up to Pretoria, where he made the final arrangements for lighting the town. The fact of their having obtained that contract was likely to be the means of establishing for them a very considerable and valuable business throughout South Africa. He had also made arrangements for their being represented in the Transvaal, and was asked to report to the Town Council of Durham and met representatives of the Town Council of Capetown. As a result there was a fair prospect of business being done. Altogether he might say that having been round the world he was better able to meet the questions they might have to deal with, and therefore he had the greatest satisfaction in having made the trip.

The re-election of the Auditors having been unanimously carried, a hearty vote of thanks to the Chairman brought the proceedings to a close.

MANCHESTER EDISON-SWAN COMPANY.

REPORT.

The Directors beg to submit the accompanying balance-sheet for the year ending 30th May, 1891. The net profit, including last year's balance, amounts to £2,292. 10s., which it is proposed to appropriate as follows:

To payment of dividend at 5 per cent. per annum ...	£1,000	0	0
To payment on account of 5 per cent. cumulative preferential dividend on the "A" shares at the rate of 1¼ per cent. on £40,000 (the original paid-up capital of the Company), for the year ending 31st May, 1883	500	0	0
Balance to be carried forward	792	10	0
	£2,292	10	0

If the above be approved, the dividend warrants will be issued on 1st August, 1891. Since the last general meeting the Directors have had to deplore the loss, by death, of their esteemed colleague, Mr. Edward Cross. The Directors have filled this vacancy on the Board by the election of Mr. Frederick B. Ross as a director of the Company. Mr. W. P. James Fawcus, the Company's manager, has been elected to fill the vacancy on the Board caused by the resignation, through ill-health, of Mr. J. R. Williamson, and the shareholders are asked to confirm his appointment as director. Mr. Frederick B. Ross retires in accordance with the Company's articles of association; he is, however, eligible, and offers himself for re-election.

The ninth ordinary general meeting of this Company was held on Wednesday in Manchester, Mr. V. K. Armitage, chairman, presiding.

The **Chairman**, in moving the adoption of the report, explained that the dividend of 1¼ per cent. on the £40,000 was on the original capital, which was entitled to 5 per cent. cumulative dividend before any money out of profits was paid on the B shares to the present Company, and now, for the first time, they were able to come back to 1883 and pay something on account of the £40,000. The amount it was proposed to pay was £500, and it came to 1¼ per cent. The report and accounts showed that they had made a profit of £1,645, and adding to that £647. 6s., balance from last year, they had at their disposal £2,292. 10s. Since the extraordinary meeting of the Company was held some months ago, the Directors had tendered for one or two large installations, but they did not see that they would make very much out of them if they got them, and so they did not persevere with them. They had come to the conclusion that their money might very well be spent in another quarter altogether. Some 18 months or two years ago, when Mr. Williamson, who was then the managing director of the Company, went out to Sydney for the benefit of his health, five or six of them, who had confidence in his trustworthiness and ability, joined together and formed a little company with a nominal capital of £5,000, of which £2,500 was called up. Well, Mr. Williamson had not been out in Australia 12 months before orders were pouring in upon them, and they foresaw a time when the capital of the little company would be as a mere drop in the bucket. It was then suggested that instead of allowing the money of the Manchester Edison-Swan Company to lie idle at the bank, it would be well to invest it in shares in the Williamson Company, and after considerable deliberation with those directors of the Edison-Swan Company who were not in the smallest degree interested in the Williamson Company, they arrived at the unanimous conclusion that it was the best thing they could do; £2,500 of the Company's money had accordingly been invested on advantageous terms in the Williamson Company. Mr. Williamson had a great deal of business in hand, and when that was got out he had good ground for hoping that he would be able to get more. With regard to the prospects of the Company, he could add little to what he had said at previous meetings. They had tendered, together with a number of other firms, for the lighting of the Manchester Town Hall, and they were hopeful that their tender might be successful. They sincerely believed that when they had got the Town Hall lighted with electricity it would be such an improvement on the present arrangement that the Corporation and the citizens would be encouraged to use the electric light more freely. In conclusion, the Chairman assured the shareholders that the price at which the shares of the Company were knocked about on the Stock Exchange did not by any means represent their intrinsic value. Unless to people who were buying or selling the shares for gambling purposes, it did not matter one straw at what price they stood on the Stock Exchange. The great thing was, what did the shareholders get at the end of the financial year on the amount of money they had invested? He thought that was the way in which to judge the *bona fide* value of the shares. He moved the adoption of the report and accounts.

This was seconded by **Mr. I. C. Waterhouse.**

In reply to a question by Mr. C. Agnew, the **Chairman** stated that the Directors were acting quite in accordance with the articles of association in entering upon the Australian business. In the past, so long as they could make a profit, they had not hesitated to do business in any part of the world.

Mr. Becker, while not seeking to cast a doubt on the probable profitableness of the Australian business, said he thought the Directors had been somewhat unceremonious in launching out into such work without consulting the shareholders.

The **Chairman** defended the action of the Directors, and the resolution for the adoption of the report was carried unanimously.

The dividends recommended in the report were declared payable, and the thanks of the shareholders were accorded to the Directors, to whom a sum of £150 was voted for their services.

COMPANIES' REPORTS.

TELEPHONE COMPANY OF IRELAND.

The report of the Directors for the year ending December 31, 1890, states that inasmuch as the articles of association require that the accounts shall be made up to a date not more than four months before the annual meeting, a supplementary statement of accounts is also presented herewith for the half-year ending June 30, 1891. The negotiations for the raising of additional capital have now been satisfactorily concluded. The Company is now entitled to some reduction of the instrument royalties, and, in accordance with the terms of the agreement between the United Telephone Company and this Company, the amount of such reduction will be settled by arbitration. The accounts now submitted are therefore subject to adjustment, according to the decision of the arbitrator. The amount standing to the credit of the net revenue account as upon December 31, 1890, including the balance brought from last account, amounts to £4,950, against £4,459 for the year 1889. Out of this sum there has been paid an interim dividend upon the preference shares for the half-year ended

NOTES.

Ballinskelligs.—The Direct United States Cable Company are about to commence at once the erection of a telegraph station at Ballinskelligs, a short distance from Valentia Island.

Prince of Monaco's Yacht.—This yacht, which is built and fitted up for scientific purposes, is lighted throughout by electricity. The installation has been carried out by Messrs. Woodhouse and Rawson.

Christiania.—The Christiania Corporation are inviting tenders for the erection of electrical works for about 12,000 lamps. Tenders are to be sent in, addressed to the Christiania Magistracy, by September 12.

New Cables.—The Western and Brazilian Telegraph Company, Limited, state that an expedition is now in Brazil laying new cables from Santos to Rio de Janeiro, Rio de Janeiro to Bahia, Bahia to Pernambuco.

Electric Railways in Italy.—A scheme, it is stated, is under consideration for the construction of an electric railway from Aosta to Pré-Sainte-Didier. The project will, if carried out, bring into existence the longest electric railway in Europe.

Electric Cars for Edinburgh.—The Lord Provost's Committee of the Town Council have under their consideration at the present time a proposal to experiment with electric cars in Leith-walk with the overhead wire method common in America.

Dalton Local Board.—A letter from Messrs. Nicholson and Jennings having been read at the Board's monthly meeting as regards lighting the streets with electricity, it was decided to refer the matter to the Highways and Lighting Committee.

Waterford.—A special meeting is to be held by the Town Council on September 1 to consider the advisability of applying to the Board of Trade for a license to supply electricity for public and private purposes. It is estimated that if a license is obtained the Council will approach the electric lighting company with a view to purchase.

Montrose.—The new hospital lately added to the asylum, the main building, and superintendent's house are electrically lighted. Manchester dynamos, driven by high-speed engines, are used, and, as a stand-by, a battery of accumulators sufficient to supply current to 50 lamps for 10 hours is installed. Altogether there are some 430 16-c.p. incandescent lamps.

Southampton.—Tenders are being invited by the Southampton Harbour Board for lighting the Royal Pier, Southampton, by electric light; also for providing and fixing two electrical cranes on the Town Quay, Southampton. Plans can be seen at the office of the engineer, Mr. J. G. W. Aldridge, 9, Victoria-street, Westminster. Tenders are to be sent in on or before the 24th inst.

Taunton.—The chairman of the gas company has been congratulating the shareholders upon the increased consumption of gas—and this in the face of competition with the electric light. This bears somewhat in favour of the views of many engineers that the introduction of the electric light should be favoured by the gas companies, in that it leads to the burning of more gas.

Electric Courting.—Paris, says the *Scientific American*, is laughing over a joke about an American inventor who is said to have patented an electric corset, calculated to bring about the reign of morality at once. If one of these articles is pressed by a lover's arm it emits a shriek like a railway whistle. The inventor claims to have already married off three of his daughters to their too backward lovers by the publicity thus thrust upon them!

Lampposts.—Electric Light: "Does your mother know you're out, Mr. Lamppost?" Lamppost: "Oh, yes; and you're to blame for it, too, you stuck-up thing, that you are." Electric Light: "Well, that's pretty strong, now; but then, you always were a little gassy, and a little, just a little, light in the head, you know." Lamppost: "You needn't talk, for you're a good deal lighter in the head than I ever was." Electric Light: "Oh, thank you."

Egremont.—At the monthly meeting of the Local Board, held last Friday, a report by the surveyor with regard to the utilisation of water power for electric lighting was considered, as was also other communications on the same subject. It was ultimately decided to adopt the motion of Mr. Simon, to the effect that a committee, consisting of Messrs. Smith, Bouch, Armstrong, Stout, and Davidson, be appointed to consider the letters, with power to call in professional assistance, if necessary.

Telegraph Engineers.—In reply to a question put by Mr. Webb in the House of Commons, the Postmaster-General stated that the engineering branch of the General Post Office performs work of a special character, and there does not appear to be any reason for making its classification uniform with that of another branch. The proposals affecting the pay of certain classes of engineering officers have been submitted to the Treasury, and are now receiving their Lordships' careful consideration.

Invention of the Electric Telegraph.—*Electricité* points out that Ampère and Babinet in 1822 mentioned that the deflection of a magnetic needle could be used to transmit signals to a distance. The application of it by Gauss and Weber, in 1833, published in 1834, at Gottingen, was considered by Gauss (Weber claiming no part of the discovery) as of only secondary importance. Our contemporary adds that it knows of no publication of actual results anterior to 1833, and if any exist would like to hear of them.

The Electric Light in Dentistry.—We now have the electric light to aid us in our dental operations, and I find, says Dr. Pruyn, by its use I can discover imperfections in cavities I have prepared that had previously escaped my attention. This is because the electric light gives a paler white light, and it is more intense than daylight. It is particularly so in that form of decay known as the white decay. You may prepare the cavity with the ordinary care, having it seemingly perfectly dry, and a magnifying glass will show you no imperfections, but with the aid of the electric light you find them.

Manchester Central Station.—The Cheshire Lines Committee have recently decided to erect an installation for the complete lighting of their central station, Manchester, and have placed the order for the whole of the plant with Messrs. Mather and Platt, of the Salford Iron Works. The plant will consist of incandescent lamps for the refreshment-rooms, ticket offices, and waiting-rooms, and of arc lights for the platforms. The plant is to be in duplicate throughout, and will consist of compound engines, Edison-Hopkinson dynamos for the incandescent lighting, and Manchester dynamos for the arc lighting.

Mercury Switch.—We notice that a "new type" of switch is described as in use at the works of M. Jacques Ullmann, in France, and others have introduced a similar arrangement for the avoidance of sparks at the point of

Manchester, they are now prepared to give prompt delivery from stock of wires and cables for electrical purposes in vulcanised, pure indiarubber, and guttapercha insulations, silk and cotton covering, and their patent braiding, also armoured and lead-covered cables in all sizes, concentric cables, and their patent anti-induction and other telephone cables. Mr. Henry Edmunds desires us to call the attention of his friends to his change of address as above.

Anti-Magnetic Alloys.—M. Roussaille, president of the Syndical Chamber of Watchmakers of Lyons, in his paper upon "Watchmaking" at the Paris Exhibition, cites the following anti-magnetic alloys employed in the manufacture of watches: (1) "Mangor," an alloy of manganese and gold; (2) "Wolfor," composed of wolfram and gold; (3) "Woltine," formed by the union of platinum and gold; (4) "Cadmine," an alloy of which cadmium forms a large part—it is very hard and very elastic. To the alloys mentioned by M. Roussaille are added: (5) "Aror," composed of cadmium, gold, and manganese, and (6) "Manium," formed of manganese, platinum, bismuth, and copper. The anti-magnetic alloy best known in England—Hadfield's manganese steel, composed of a small percentage of manganese, added to ordinary steel—does not appear to have been mentioned.

Electric Light Fishing.—A fishing sloop left San Diego, recently, on a novel expedition, to last from one to three months. An electric plant has been put on board, and the fishing is to be done by the aid of incandescent lights and a net. Experiments in the bay proved that everything alive under the water is attracted by the glare of the light, and that thousands of fish of every description can be taken in a short time and with very little trouble. Four men were on board, and the boat has steered for the banks near San Clemente Island. The practical result of the first voyage will be watched with much interest, and if it is as successful in deep water as the experiments in the bay have been, the projectors of the enterprise are confident they will have solved the problem of supplying all Southern California with cheap fish. W. G. Riffenberg, a citizen of San Diego, is the inventor of the apparatus.

Helston.—At the last meeting of the Helston Town Town Council, Mr. J. E. Veale, of St. Austell, who has been consulted on the question of electric lighting, gave as his opinion that the proposed lighting is practicable, and that the disposition of the town lighting will adopt itself well to the electric light. Three plans are suggested for carrying out the work; the first is to utilise the water power available at Lower Town to transmit the electricity from thence to a centre near the market-house and distribute it through the various streets and buildings by about five miles of underground cables. The second plan is to use gas engines with gas obtained on the Dowson system, and the third is to use oil engines. The estimated cost of the plans is, respectively, £2,070, £1,724, and £1,590. The annual cost is estimated at: water power, £198. 10s.; gas, £192. 4s.; and oil, £185. 10s. Letters on the same subject were received from the Manchester Edison-Swan, and from Messrs. J. E. H. Gordon and Co.

Sims-Edison.—The following is from the *Times*: "There is to be a new application, of high importance, of the Sims-Edison invention for propelling and controlling torpedoes, which was exhibited in May last at Havre and described at length in the *Times*. The principle of control has been utilised in connection with lifeboats by the distinguished scientist Mr. Edison and the eminent engineer, his colleague. At present a boat, with sides necessarily low enough for rowing, is propelled through the surf by 10 to 12 men, who, at the risk of their lives, produce about 1 h.p. The idea in the minds of Mr. Edison and Mr. Sims has been to exchange this feeble force for the all but unlimited power of electricity. The boat they have designed could be sent through the surf for miles up and down the coast, if necessary, and out to a vessel in distress with a force of 32 h.p. Only two men are required to steer it, and the elaborate devices necessitated by the torpedo are not needed."

Taunton.—We regret that we cannot enter fully into a description of the electrical exhibition, but at present merely say that Field-Marshal Sir J. Lintorn Simmons on Saturday performed the opening ceremony. The exhibition (which is held at the Taunton Electric Lighting Company's central electric lighting depot) is not large, but it is comprehensive, and is intended to illustrate the various uses to which electrical power can be applied. For instance, an oil engine drives a Newton dynamo, which conveys the electric current to a large number of electric incandescent lamps of various artistic shapes. The same power also drives small motors attached to sewing machines, and also warms a patent lubricator, by means of which eggs are hatched by electricity, and works a churn. An electric launch has been placed on the Tone, in which short trips are taken up and down the river. At a luncheon at which Sir J. L. Simmons was entertained, the gallant Field-Marshal referred to the Sims-Edison torpedo as being an important stop in naval warfare.

Edinburgh.—The Corporation of Edinburgh have now obtained the Royal assent to their electric lighting provisional order. In the Act confirming it, which is known as the Electric Lighting Orders Confirmation (No. 6) Act, 1891, Edinburgh and Paisley were bracketed together. At Tuesday's meeting of the Town Council, Mr. Auldjo Jamieson asked what was to be done with it. Since Tuesday, the committee which was in charge of the order while it was in Parliament sat to consider what they were to do, and came to the conclusion that in procuring the order they had exhausted their duties; and that they could only report the matter to the Council, and wait for further instructions. "This does not look," says the writer in the *Journal of Gas Lighting*, "as if there was much eagerness to take up electric lighting; and I believe this to be the fact. Had it not been to keep out speculative companies, the provisional order would never have been heard of. Mr. Jamieson's question must, however, be answered; and it will be interesting to watch how the Corporation set about the carrying out of the very unwelcome task which has been thrust upon them by the order."

Frankfort Exhibition.—The work of transmitting 300 h.p. at a distance of 120 miles upon the line Lauffen, Frankfort, which was begun about the middle of July, is progressing very favourably. On the line Frankfort-Jagsefeld, which is being built by the Imperial Government, eight gangs of workmen are busily engaged, whilst three gangs are working on the Wurtemberg side. The vast material necessary for the building of the line, consisting of specially constructed telegraph poles, cross-bars, and insulators, having arrived on the spot in good time, and aided by the practical and energetic measures of the employés engaged upon the work, nearly all the telegraph poles along the whole line are in their places, in spite of unusual difficulties connected with the mountainous nature of the soil having had to be surmounted. Thanks to the exertions of the firm of Hesse Söhue Heddernheim, who delivered the necessary quantity of above 1,200 miles of copper wire at the respective places within the space of a few days, the putting up of the wires will begin next week. Not less than 750 kilogrammes of oil will be will, however, be interesting: The apparatus in use hitherto for the storing of electric energy (accumulators) are based upon certain chemical reactions which occur only at the electrodes, so that with apparatus of this type the same electrodes are obliged to be used for both charge and discharge. This is not without its inconveniences, especially when the discharge is to take place at some other place than the charge. In the Marx process the electrical energy is stored, not at the electrodes, but in a liquid subjected, by means of a special charging apparatus by means of the electric current, to a determined chemical change. This liquid, charged, so to speak, by the electric current, has been termed "electroline." The electrodes of charge may be any conducting substance, such as carbon; the discharge electrodes may be of metal. An example will serve to make the process clearer. A glass vessel is filled with 450 grammes of chloride of iron, 900 grammes of water, and about 500 grammes of hydrochloric acid. After the salt is dissolved, two or three plates (in the latter case two positive and one negative) are placed within the bath without touching and correspondingly connected to the positive and negative poles of a dynamo. The passage of the current causes a decomposition of the liquid, which turns greenish, then yellow, and finally passes to a yellowish brown. When the liquid will not absorb further energy, the negative plates are removed and then the positive. While the present accumulators only return their charge with the same electrodes, the electroline requires a change of plates, one of metal and one of higher resistance, such as carbon. A plate of very porous carbon on one well pierced with holes is placed between two metal ones—zinc, copper, or iron. If now the circuit is completed an energetic current is given off, while the liquid decomposes, passing by the same series of colours in inverse order.

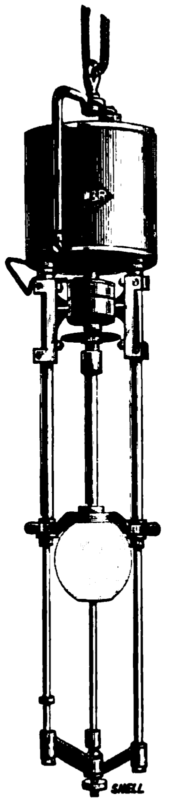
Cuba-Brazil Cables.—On the 31st ult. the engineer-in-charge, Mr. Theophilus Smith, telegraphed that the Cayenne-Viseo section of these cables was successfully laid. This completes the system of about 2,500 nautical miles which Mr. Sharpey Seaton, the acting partner (for this special purpose) of the Société Générale des Téléphones, undertook to lay for the Société Française des Télégraphes Sous-Marins under contracts made in July and August of last year. The programme of the first expedition was drawn up on the 17th September, 1890. It was to commence on the 15th October and to last 78 days, but subsequently 14 days' extra work were added to the programme, thus extending it to 92 days. The "Westmeath" passed Dover on the 17th October outward, and on the 17th January homeward bound (92 days). The programme of the second expedition was drawn up on 6th March, 1891. It was to commence about 20th April and to last 117 days. The "Westmeath" sailed on 22nd April, and completed her work on the 31st July (100 days). The voyage would occupy 17 or 18 days if the "Westmeath" came direct, but it has recently been decided to give the ship extra work in laying the spare cable between St. Pierre and Fort-de-France and elsewhere. The "Ludgate" was taken up for a minimum period of four months; she will be redelivered to her owners before its expiration. During these four months she has been fitted with cable tanks and gear, has laid 2,250 tons of cable between Surinam and Brazil, and she is now being dismantled for restoration to her owners. The first expedition was directed by Mr. Seaton in person; the second by Mr. Theophilus Smith, who is assisted by Messrs. Stallibrass, Page, Schischkar, Hall, Roussel, Fisher, Bevan, Sullivan, Spain, and other engineers and electricians, as well as by Captain Stonehouse and Mr. Dunn, the chief of the engine-room. The first message over the new cable was addressed to President Carnot by the Governor of Guayana and the President of the Council-General. Of the cables above mentioned, about 1,000 miles were manufactured by Messrs. Henley and Co., in London, the remainder by the Société Générale des Téléphones, at their newly-established works at Calais. There are altogether some nine or ten different types of cable, but the shore ends are principally about nine-ton, and the main cable about four-ton cables.

Bacup Town Council.—At the monthly meeting of this Council Mr. Heyworth (town clerk) read the following letter relating to the electric lighting of Bacup: "Royal Insurance-buildings, Newcastle-on-Tyne, July 7th, 1891. Dear Sir,—In reply to your esteemed favour of the 26th ult. *re* electric lighting, we beg to say we have carefully considered the matter, and would suggest an installation of 100 arc lamps as suitable for your town lighting. The cost of such an installation—consisting of engines, boilers, dynamos, a suitable engine-house, 100 arc lamps each of 2,000 c.p. nominal, 100 iron lampposts, wooden poles to support overhead wires, insulated copper wire to fulfil Board of Trade requirements, and everything necessary to make a complete installation—would be about £9,000. The cost of working such an installation, if the authorities had it in their own hands and worked it themselves, would be as follows: Wages £4 per week, coal 4cwt. per hour, and carbons, etc., 2s. per hour, for the time all the lamps are burning. The light given by 100 arc lamps would be 100,000 c.p., whereas the light given by your present 632 gas lamps will, at best, not exceed 6,000 c.p. The annual rental, including purchase of plant, which we would charge for putting down, maintaining against all risks, and working the installation, under a guarantee to provide a constant and efficient light, would be about £25 per lamp per annum, plus the proportion of the cost agreed to be paid off annually, and 5 per cent. interest on the remainder. It would decidedly be to the advantage of the authorities for them to purchase the plant and work it themselves, and allow us to maintain it in good working order, at a very much reduced yearly charge. The current for incandescent lighting by private consumers could be generated at 2d. to 3d. per unit, which is equivalent to gas at from 1s. 2d. to 1s. 8d. per 1,000 cubic feet. The charge to private consumers in Newcastle is 6d. per unit, and in London 8d. per unit, so you will see that a fair profit could be derived from this source. Should your authorities think favourably of adopting the electric light we shall be glad to make a careful survey of the district, and give you a definite estimate, on payment of our representative's travelling expenses, and to give you any other information or advice in our power free of charge. Trusting the foregoing will be sufficient for your preliminary discussion,—We remain, yours obediently, Nicholson and Jennings. P.S.—Comparative cost of electric lighting and gas lighting:—British Museum: Electric light costs 6s. per hour, gas costs 15s. per hour; Albert Hall: Electric light costs £1. 10s. 6d. per night, gas costs £4. 7s. 6d. per night; South Kensington Museum: Electric light costs £1,224 per annum, gas costs £2,845 per annum. Thames Embankment: Electric light costs 5·66d. per 1,000 c.p. per hour, gas costs 1s. per 1,000 c.p. per hour. Dr. Cheadle, F.R.C.P., in a paper he recently read on 'The Progress of Hygiene,' says: 'The great injury inflicted by gas-polluted air is shown by the recent experience of the Great Western Railway Company. It is stated that since the electric light was introduced into their offices the percentage of absences from illness has fallen from 10 per cent. to 2 per cent. The introduction of the electric light will do much for the sanitation of houses, shops, and offices.'"

shadow, and minimises any complaint which may be urged against the inequality of the distribution of the light.

The principle upon which the lamp works may almost be called simplicity itself. The upper part of the rods forming the frame of the lamp are hollow, and in these the lower portions slide quite easily. The bottom carbon is attached to the lower part of the frame, which is fastened to the upper portions of the lamp by a chain passing up the hollow pillar forming the upper portion of the lamp, round a pulley-wheel, whose motion is controlled by clockwork, and then to the upper carbon-holder, which acts as a counterpoise and slides freely between the hollow pillars forming the frame of the lamp.

The motion of the pulley is controlled by clockwork, which is started and stopped by a pivoted bar, on whose under surface a number of teeth are situated. These engage a pointer attached to the pendulum of the clock. This bar is pivoted in the centre, and attached each end to iron plungers which move inside the cores of electromagnets actuated respectively by the main and shunt circuits. When, owing to the distance between the carbon points, the resistance of the main circuit increases, and consequently the current through the shunt increases, the plunger is drawn further into the core round which the shunt circuit passes and the pendulum is released; the clockwork moves the carbons nearer together until the main circuit increases so much as to draw the other plunger into the core round which it passes, and so overpowers the effect of the shunt circuit. The bar is drawn down, the teeth engage the pendulum of the clockwork, and the carbons are maintained apart until, owing to the burning away, the same action is repeated. This action is so delicate that no inconvenience at all is caused by the intermittent feed—indeed, it is scarcely noticed.



The Midget Arc Lamp.

When the current is stopped the pendulum is released, owing to the action of a spring upon the bar, and the clockwork causes the carbons to remain together.

In the small box over the upper carbon-holder, the current, before passing to the carbon, magnetises an iron core, and lifts the upper carbon a small distance above the lower one, and thus forming the arc when the current is first put on the lamp. The carbon is held up in this manner all the time the current is passing through the lamp. The lamp in wound in three different ways—one suitable for parallel working, one for series, and one for use with alternating currents.

ELECTRIC LIGHT ON SHIPBOARD.*

SYSTEMS OF WIRING.

Electric light being now an absolute necessity on a large proportion of the mercantile as well as the fighting navies of the world, and a knowledge of the requirements connected with its use having hitherto been almost entirely confined to the specialists by whom it is installed, we have thought that shipowners would be glad of a short statement, given as far as possible in non-technical language, of the methods adopted for the wiring of their boats, and the precautions necessary to guard against the occurrence of fires. As a preliminary to this statement, however, it will be well to point out the place occupied by the wiring in regard to the whole installation. A system of electric lighting is not analogous to a system of gas lighting. In the latter case, the current of gas has to be conveyed from the source of supply to the illuminating flame, after leaving which, in a changed condition, it is generally left to poison the atmosphere and shift for itself. The electric current, on the other hand, is unchanged in both volume and nature after passing through the lamp, and has to be led back to the dynamo, to be, as it were, again put under pressure for further use. The electric circuit may, as a popular exposition of the subject, be likened to the flow of water round and round in an endless pipe. At one point the pipe is enlarged to receive a pump, and at other points is obstructed, say, by pieces of sponge or porous stone, to force the full body of water, through which great pressure has to be exerted by the pump. In the electric analogue the pump is represented by the dynamo, the pipe by an insulated metal conductor, and the obstructing sponges by the lamps. Certain practical considerations prevent the placing of the lamps all in a row, one after the other, or, as it is termed, "in series," on one circuit, or even on a considerable number of circuits. The arrangement of each circuit is as if two large water mains were carried along the ship, side by side, and connected to the pump, so that water is drawn from one main and delivered into the other. Instead of having their further ends joined together, so as to form one endless pipe, as in our previous supposition, the two mains are connected at intervals, as required, by branch pipes containing sponges. In each of these branch-connecting pipes a tap may be inserted for the purpose of turning the water on or off as required. With this arrangement the pump has to maintain a constant difference of pressure between the two mains, and each sponge passes the proper amount of water, however many or few are in action at once. A sponge in a water-pipe may not at first seem a good simile for a bright light, but on consideration it will be found not inapt. The incandescent or glow lamp (the lamp universally used on board ship, except for special purposes, such as powerful search-lights) owes its brightness to what may be called friction between the electric current and the thin thread of carbon, known as the "filament," along which it has to travel. In this case the conductor is so small and the current so comparatively large that the friction makes the conductor white hot. The light then is merely an incidental effect due to a thin strip of carbon being heated. Now, though the sponge in the water-pipe does not become white hot and give light, the difference in effect is only in degree; the sponges, water, and pipes do become warmed in proportion to the work done in forcing the water through its circuit, just as the lamp filament and conducting mains become warmed in proportion to the work done in forcing the electric current through them. In the former case a large mass of matter is heated to a small extent, while in the latter the effect is concentrated on a very small mass of matter, which, therefore, is intensely heated. The conducting wires may, we see now, be for practical purposes considered as acting the part of pipes, and the lamps as obstructions in them; for, more correctly, the indiarubber or other insulation surrounding the wire acts the part of the metal in the pipe, and the conductor in the centre acts as the hollow space inside the pipe. The nature of electric currents—if currents they really are—and why they can pass through a dense metal like copper six times as easily as through iron, or nine thousand million million fact that the effect most likely to be produced is simply a gradual heating, which, when far enough advanced, could not fail to be observed. The principal necessity is then to prevent the streams between the primary and the tube, not only on account of the heating and possible injury, but also because the streams may diminish very considerably the potential difference available at the terminals. A few hints as to how this may be accomplished will probably be found useful in most of these experiments with the ordinary induction coil.

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* From the *Liverpool Journal of Commerce*.

One of the ways is to wind a short primary, Fig. 17A, so that the difference of potential is not at that length great enough to cause the breaking forth of the streams through the insulating tube. The length of the primary should be determined by experiment. Both the ends of the coil should be brought out on one end through a plug of insulating material fitting in the tube as illustrated. In such a disposition one terminal of the secondary is attached to a body the surface of which is determined with the greatest care so as to produce the greatest rise in the potential. At the other terminal a powerful brush appears, which may be experimented upon.

The above plan necessitates the employment of a primary of comparatively small size, and it is apt to heat when powerful effects are desirable for a certain length of time. In such a case it is better to employ a larger coil, Fig. 17B, and introduce it from one side of the tube, until the streams begin to appear. In this case the nearest terminal of the secondary may be connected to the primary or to the ground, which is practically the same thing, if the primary is connected directly to the machine. In the case of ground connections it is well to determine experimentally the frequency which is best suited under the conditions of the test. Another way of obviating the streams, more or less, is to make the primary in sections and supply it from separate well-insulated sources.

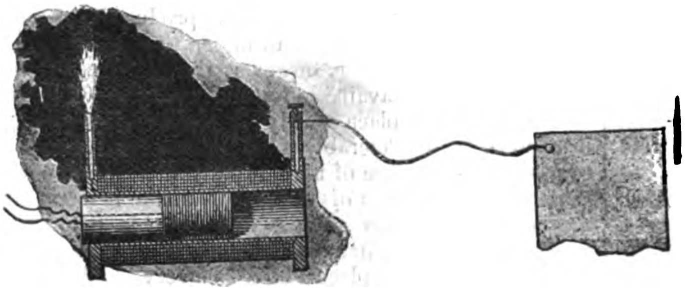


FIG. 17A.

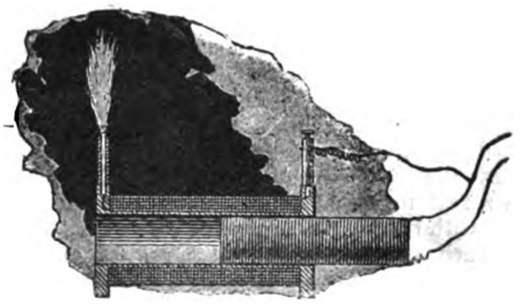


FIG. 17B

In many of these experiments, when powerful effects are wanted for a short time, it is advantageous to use iron cores with the primaries. In such case a very large primary coil may be wound and placed side by side with the secondary, and, the nearest terminal of the latter being connected to the primary, a laminated iron core is introduced through the primary into the secondary as far as the streams will permit. Under these conditions an excessively powerful brush, several inches long, which may be appropriately called "St. Elmo's hot fire," may be caused to appear at the other terminal of the secondary, producing striking effects. It is a most powerful ozoniser, so powerful, indeed, that only a few minutes are sufficient to fill the whole room with the smell of ozone, and it undoubtedly possesses the quality of exciting chemical affinities.

For the production of ozone, alternating currents of very high frequency are eminently suited, not only on account of the advantages they offer in the way of conversion but also because of the fact of the ozonising action of a discharge is dependent on the frequency as well as on the potential, this being undoubtedly confirmed by observation.

In these experiments if an iron core is used it should be carefully watched, as it is apt to get excessively hot in an incredibly short time. To give an idea of the rapidity of the heating, I will state that by passing a powerful current through a coil with many turns, the inserting within the same of a thin iron wire for no more than one second's time is sufficient to heat the wire to something like 100deg. C.

But this rapid heating does not need to discourage us in the use of iron cores in connection with rapidly alternating currents. I have for a long time been convinced that in the industrial distribution by means of transformers, some such plan as the following might be practicable. We may use a comparatively small iron core, subdivided, or perhaps not even subdivided. We may surround this core with a considerable thickness of material which is fireproof and conducts the heat poorly, and on top of that we may place the primary and secondary windings. By using either higher frequencies or greater magnetising forces, we may by hysteresis and eddy currents heat the iron core so far as to bring it nearly to its maximum permeability, which, as Hopkinson has shown, may be as much as 16 times greater than that at ordinary temperatures. If the iron core were perfectly enclosed it would not be deteriorated by the heat, and, if the enclosure of fireproof material would be sufficiently thick, only a limited amount of energy could be radiated in spite of the high temperature. Transformers have been constructed by me on that plan, but for lack of time no thorough tests have as yet been made.

Another way of adapting the iron core to rapid alternations, or, generally speaking, reducing the frictional losses, is to produce by continuous magnetisation a flow of something like 7,000 or 8,000 lines per square centimetre through the core, and then work with weak magnetising forces and preferably high frequencies around the point of greatest permeability. A higher efficiency of conversion and greater output are obtainable in this manner. I have also employed this principle in connection with machines in which there is no reversal of polarity. In these types of machines, as long as there are only few pole projections, there is no great gain, as the maxima and minima of magnetisation are far from the point of maximum permeability; but when the number of the pole projections is very great, the required rate of change may be obtained, without the magnetisation varying so far as to depart greatly from the point of maximum permeability, and the gain is considerable.

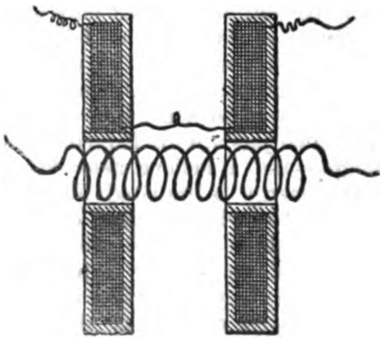


FIG. 18.

The above described arrangements refer only to the use of commercial coils as ordinarily constructed. If it is desired to construct a coil for the express purpose of performing with it such experiments as I have described, or, generally, rendering it capable of withstanding the greatest possible difference of potential, then a construction as indicated in Fig 18 will be found of advantage. The coil in this case is formed of two independent parts which are wound oppositely, the connection between both being made near the primary. The potential in the middle being zero, it with a source of rapidly alternating potential. The heating in such a case is, in all probability, due mostly to the bombardment of the molecules of the gas contained in the bulb. When the bulb is exhausted the heating of the body is much more rapid, and there is no difficulty whatever in bringing a wire or filament to any degree of incandescence by simply connecting it to one terminal of a coil of the proper dimensions. Thus, if the well-known apparatus of Prof. Crookes, consisting of a bent platinum wire with vanes mounted over it, Fig. 19, be connected to one terminal of the coil—either one or both ends of the platinum wire being connected—the wire is rendered almost instantly incandescent, and the mica vanes are rotated as though a current from a battery were used. A thin carbon filament, or preferably a button of some refractory material, Fig. 20, even if it be a comparatively poor conductor, enclosed in an exhausted globe, may be rendered highly incandescent; and in this manner a simple lamp capable of giving any desired candle-power is provided.

The success of lamps of this kind would depend largely on the selection of the light-giving bodies contained within the bulb. Since, under the conditions described, refractory bodies—which are very poor conductors and capable of withstanding for a long time excessively high degrees of temperature—may be used, such illuminating devices may be rendered successful.

It might be thought at first that if the bulb containing the filament or button of refractory material, be perfectly well exhausted—that is, as far as it can be done by the use of the best apparatus—the heating would be much less intense, and that in a perfect vacuum it could not occur at all. This is not confirmed by my experience; quite the contrary, the better the vacuum the more easily the bodies are brought to incandescence. This result is interesting for many reasons.

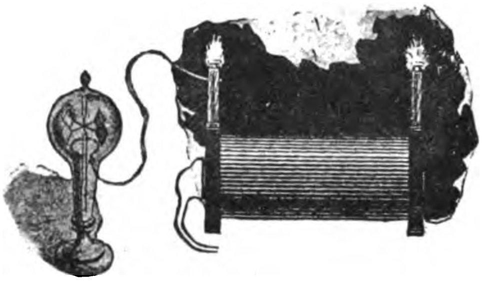


FIG. 19.

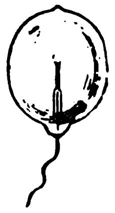


FIG. 20.

At the outset of this work, the idea presented itself to me whether two bodies of refractory material enclosed in a bulb exhausted to such a degree that the discharge of a large induction coil, operated in the usual manner, cannot pass through, could be rendered incandescent by mere condenser action. Obviously, to reach this result, enormous potential differences and very high frequencies are required, as is evident from a simple calculation.

But such a lamp would possess a vast advantage over an ordinary incandescent lamp in regard to efficiency. It is well known that the efficiency of a lamp is to some extent a function of the degree of incandescence, and that, could we but work a filament at many times higher degrees of incandescence, the efficiency would be much greater. In an ordinary lamp this is impracticable on account of the destruction of the filament, and it has been determined by experience how far it is advisable to push the incandescence. It is impossible to tell how much higher efficiency could be obtained if the filament could withstand indefinitely, as the investigation to this end obviously cannot be carried beyond a certain stage; but there are reasons for believing that it would be very considerably higher. An improvement might be made in the ordinary lamp by employing a short and thick carbon; but then the leading-in wires would have to be thick, and, besides, there are many other considerations which render such a modification entirely impracticable. But in a lamp as above described the leading-in wires may be very small, the incandescent refractory material may be in the shape of blocks offering a very small radiating surface, so that less energy would be required to keep them at the desired incandescence; and, in addition to this, the refractory material need not be carbon, but may be manufactured from mixtures of oxides, for instance, with carbon or other material, or may be selected from bodies which are practically non-conductors, and capable of withstanding enormous degrees of temperature.

All this would point to the possibility of obtaining a much higher efficiency with such a lamp than is obtainable in ordinary lamps. In my experience it has been demonstrated that the blocks are brought to high degrees of incandescence with much lower potentials than those determined by calculation, and the blocks may be set at greater distances from each other. We may freely assume, and it is probable, that the molecular bombardment is an important element in the heating, even if the globe be exhausted with the utmost care as I have done; for although the number of the molecules is, comparatively speaking, insignificant, yet on account of the mean free path being very great, there are fewer collisions, and the molecules may reach much higher speeds, so that the heating effect due to this cause may be considerable, as in the Crookes experiments with radiant matter.

But it is likewise possible that we have to deal here with an increased facility of losing the charge in very high vacuum, when the potential is rapidly alternating, in which case most of the heating would be directly due to the surging of the charges in the heated bodies. Or else the observed fact may be largely attributable to the effect of the points which I have mentioned above, in consequence of which the blocks or filaments contained in the vacuum are equivalent to condensers of many times greater surface than that calculated from their geometrical dimensions. Scientific men still differ in opinion as to whether a charge should, or should not, be lost in a perfect vacuum, or, in other words, whether ether is, or is not, a conductor. If the former were the case, then a thin filament enclosed in a perfectly exhausted globe, and connected to a source of enormous, steady potential, would be brought to incandescence.

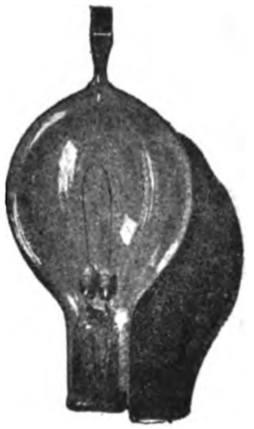


FIG. 21.

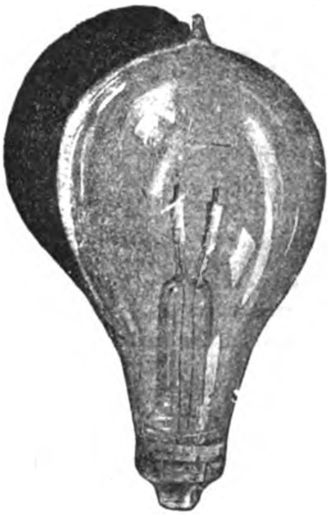


FIG. 22.

Various forms of lamps on the above-described principle, with the refractory bodies in the form of filaments, Fig. 21, or blocks, Fig. 22, have been constructed and operated by me, and investigations are being carried on in this line. There is no difficulty in reaching such high degrees of incandescence that ordinary carbon is to all appearance melted and volatilised. If the vacuum could be made absolutely perfect, such a lamp, although inoperative with apparatus ordinarily used, would, if operated with currents of the required character, afford an illuminant which would never be destroyed, and which would be far more efficient than an ordinary incandescent lamp. This perfection can, of course, never be reached, and a very slow destruction and gradual diminution of the size always occurs, as in incandescent lamps; but there is no possibility of a sudden and premature disabling which occurs in the latter by the breaking of the filament, especially when the incandescent bodies are in the shape of blocks.

(To be continued.)

amework, 46ft. high, one of which is shown to a larger scale Fig. 1. The span where the line crosses the river is 330ft., nd where it passes along the shore of the river the span is 30ft.

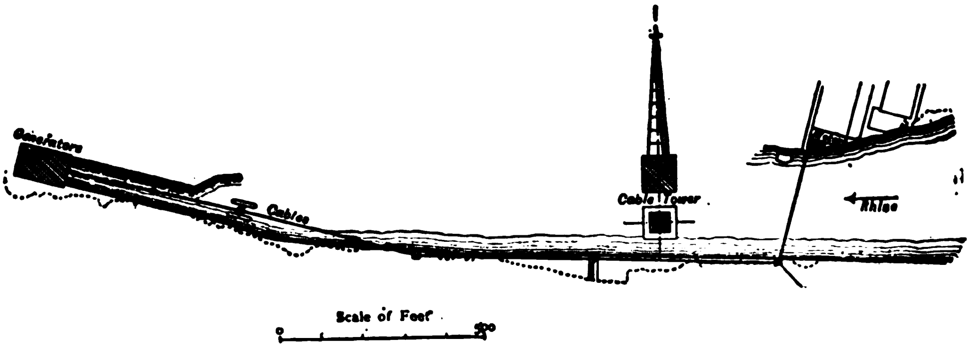


FIG. 1.

You may imagine that the proper support and insulation of ables of that size, and with so long a span, is a matter of con- iderable difficulty. The use of glass or earthenware insulators on stalk, as employed for the support of telegraph lines and other ight wires, is, of course, out of the question. We must have some- hing very much more substantial, and this has been provided n the manner shown, Fig. 5. Near the top of each post there re bolted to the iron framework four of the boxes shown on this diagram; one for each line of cables. The inner box serves as a kind of junction or connecting piece between the cable ends, which are opened out as shown. Molten zinc is then run in, and surrounds every single wire, thus making a perfect electrical joint; whilst, at the same time, the strain is divided between all the wires in the most even way possible. The inner box is surrounded by an outer box, and the intervening space is cast out with sulphur, which is an excellent insulating material, and applied in this way, of sufficient mechanical strength to resist the large forces involved in the supporting of these heavy cables.

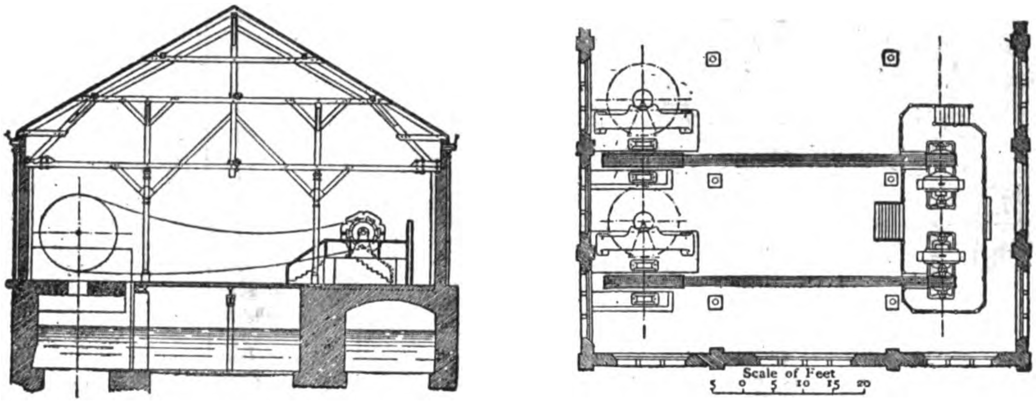


FIG. 2.

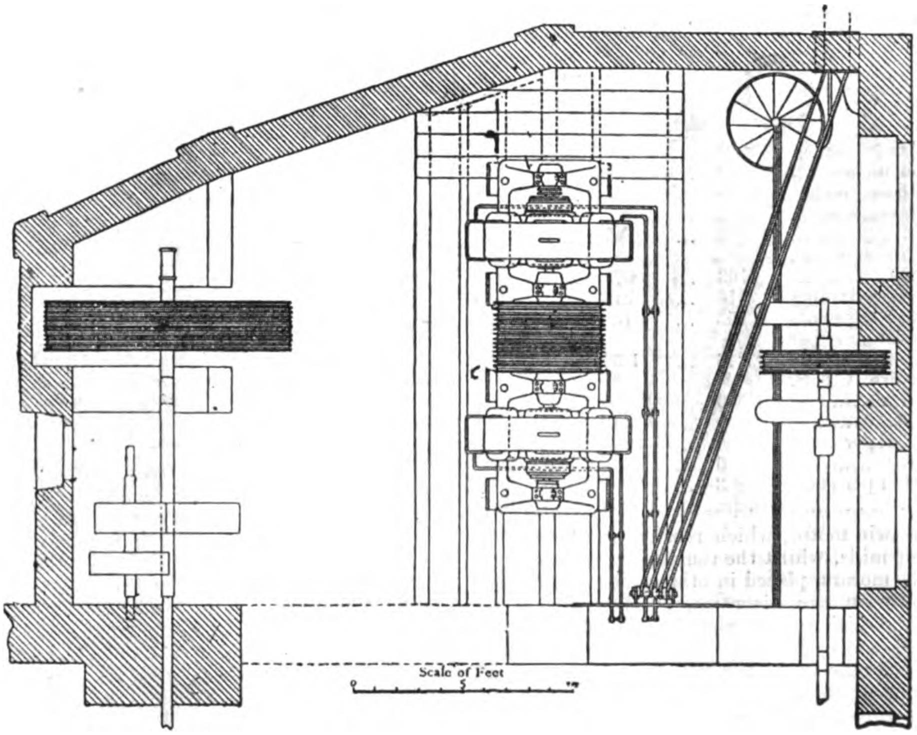


FIG. 3.

In mountainous countries, where thunderstorms are frequent and violent, the protection of lines from lightning strokes is a matter that must not be overlooked. The line I am describing is protected in a twofold manner. In the first place, there is stretched over the four electric cables a steel wire rope, passing right over the supports, and in good electric connection with their iron framework, and, therefore, with earth. The object of this arrangement is to act as an ordinary lightning protector, on the supposition that a lightning flash will rather go to earth by way of the steel cable and one of the towers that run along

BIRMINGHAM TRAMWAYS.—WORKING ACCOUNTS FOR THE TWELVE MONTHS ENDING JUNE 30, 1891.

Dr. CABLE DEPARTMENT. Cr.

Average per mile run. d.	Average per mile run. d.		£	s.	d.	£	s.	d.
		Cable haulage:						
1·46		Wages	3,180	16	8			
·66		Fuel	1,445	13	9			
·19		Stores	401	7	7			
·07		Water and gas	152	6	11			
·03		Sundries	61	16	9			
	2·41					5,242	1	8
		Cables and machinery:						
·07		Wages	159	13	1			
·88		Materials	1,918	5	8			
	·95					2,077	18	9
		Car repairs:						
·17		Wages	366	13	0			
·66		Materials	1,444	10	1			
	·83					1,811	3	1
		Traffic expenses:						
1·05		Wages	2,293	8	5			
·07		Water and gas	152	6	10			
·04		Stores	92	3	1			
·11		Stationery, tickets, and punch royalty	230	2	6			
·03		Sundries	52	12	5			
	1·30					2,820	13	3
		Permanent way and buildings:						
·01		Wages	21	15	1			
·12		Materials	256	17	5	278	12	6
	·13							
		General charges:						
·05		Stationery and incidentals	105	10	1			
·10		Salaries	214	19	11			
·08		Compensation	180	16	10			
·35		Rates, taxes, and insurances	778	15	9			
·06		Professional charges	140	5	1			
·07		Sundries	144	6	3			
	·71					1,564	13	11
	6·33					13,795	3	2
	6·50	Balance to revenue account				14,166	0	3
	12·83					£27,961	3	5

Average per mile run. d.	Average per mile run. d.		£	s.	d.
12·75		Traffic receipts	27,781		
·08		Advertisements	180		
	12·83		£27,961	3	

Note.

Miles run 522,876

Passengers carried 5,241,362

Dr. ELECTRIC DEPARTMENT. Cr.

Average per mile run. d.	Average per mile run. d.		£	s.	d.	£	s.	d.
		Electric haulage:						
2·60		Wages	1,501	16	1			
1·66		Fuel	955	13	3			
·73		Stores	420	0	5			
·07		Water and lighting	39	5	7			
·09		Sundries	53	15	10			
	5·15					2,970	11	2
		Machinery:						
·00		Wages	1	2	0			
·29		Materials	167	1	5			
	·29					168	3	5
		Car repairs:						
·60		Wages	349	1	8			
1·33		Materials	763	15	11			
	1·93					1,112	17	7
		Traffic expenses:						
1·08		Wages	619	19	3			
·07		Water and lighting	39	5	9			
·02		Stores	14	12	1			
·13		Stationery, tickets, and punch royalty	74	5	9			
·04		Sundries	23	13	8			
	1·34					771	16	6
		Permanent way and buildings:						
·08		Wages	42	18	10			
·06		Materials	35	13	6			
	·14					78	12	4
		General charges:						
·07		Stationery and incidentals	40	9	11			
·10		Salaries	57	15	7			
·08		Compensation	44	2	6			
·51		Rates, taxes, and insurances	294	0	5			
·18		Professional charges	109	2	4			
·11		Sundries	63	16	8			
	1·05					609	7	5
	9·90					5,711	8	5
	5·25	Balance to revenue account				3,020	13	3
	15·15					£8,732	1	8

Average per mile run. d.	Average per mile run. d.		£	s.	d.
1·502		Traffic receipts	8,656	10	
0·13		Advertisements	75	10	
	15·15		£8,732	1	

Note.

Line opened ...24th July, 1890

Miles run 138,396

Passengers carried 1,144,718

Smith (two of the directors) retire, and, being eligible, offer themselves for re-election. Messrs. Howard Smith, Slocombe, and Co., and Mr. G. H. Sargant offer themselves for re-election t the joint auditorship of the Company.

nding what power is required. The conductor used copper wire of 10 square millimetres, insulated and n in casing where it passes into the interior.

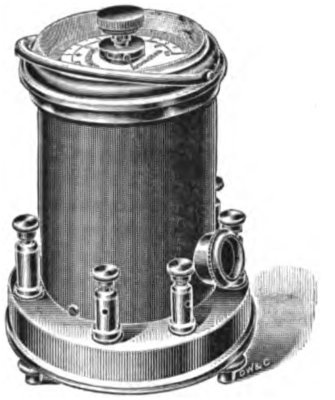
Belfast.—The report of the Gas and Electric Lighting ommittee was before the quarterly meeting of the Belfast orporation last week. The Mayor said the council had ppointed a committee some time ago to visit London for he purpose of visiting the installations of the electric light here, not for the purpose of deciding between gas and electric lighting, but to investigate the subject as to the best means of applying the electric light to the district to be ghted in the City of Belfast under the provisional order for he purpose. Following that up, their committee went to a umber of stations: Paddington, the Great Western Railway Company's station in the same district, Kensington (Hightreet), Notting Hill, Brompton, Charterhouse-square, Deptord, and the Westinghouse Company's installation. They would see, therefore, that the committee had not been negecting their duty. There were some difficulties in the way of that committee reporting fully at present. It was true that they found that the electric light was in practical operation in London, but, at the same time, they were not able to get proper data as to the cost in order to lay a full report before them. Further enquiries were being made in order to complete the report, which would be laid in a few days before them. There was a tendency in the public mind to imagine that because they were going to light a small district of Belfast by electricity that, therefore, all progress in the gas works should be stopped. No greater mistake could be made. The experience of large cities such as Manchester, Leeds, and other places, was that, although they had the electric light in full operation, the consumption of gas was actually increasing every day. He thought it was well for the citizens of Belfast that they should get it out of their minds that for the present at least the electric light was likely to be a successful rival of gas. On the contrary, there existed an urgent necessity for the extension of their present gas works, and they would have to take into consideration, at an early day, how they were going to extend those gas works. He thought they ran a great risk in going through another winter without increase of light. The report, which stated the committee hoped to report further in August, was adopted.

Birmingham Tramways.—At the annual meeting of the Birmingham Central Tramways Company on Tuesday, the chairman (Mr. Joseph Ebb Smith) made the following references to electric traction: They were bound, he said, to look forward to the future, and they knew that the abolition of steam traffic was but a question of time. It was useless to blink the fact that in future another form of traction would very probably obtain. But during the whole tenure of his office he had most scrupulously abstained from anything approaching to prophecy, and he bade them take this comfort home with them—that, having regard to the character of the main lines of the city, and having regard to the accounts of the cable department which were now before them, when the time arrived for the reconstruction of the form of traction haulage of the company the present shareholders need not fear or doubt their own position. He did not advocate any rash or sudden change. They had had a period of strain in the past; they asked for the consideration of the local authority and those in power during the period of rest and experiment, and during which they might obtain something like certainty with regard to the results of working any other systems. Whenever it did come, it would be, in his opinion, an advance from solidity of position to prosperity, and not a case of injury to the ordinary shareholder, by reason of the transformation. As to the cost of fuel during the past year, he said it would not be without interest to them if he quoted the comparative increases in the cost of the fuel during the last four years. The fuel which cost 10s. 5d. per ton in 1887 had risen step by step to more than 17s. in 1890-91. Fortunately for them the increase in the cost of fuel had been commensurate with prosperity, increased traffic, and increased profits. In answer to Mr. Whitfield as to the cost of the electric tramway in Bristol-road, the Chairman replied that, roughly speaking, the cost was about £30,000. Mr. Whitfield: What did the cable tramway cost? The Chairman said that, roughly speaking, the cost was about 50 or 60 per cent. more than the electric tramway. Mr. Whitfield: That is about £50,000. The Chairman said he was speaking of the cost of construction, but they must bear in mind the question of working, which was a more intricate subject. The motion for the adoption of the report (which we gave last week) was carried unanimously.

Gaiety Theatre, Dublin.—Ireland possesses in the Gaiety Theatre at Dublin what is described as one of the best appointed theatres in the three kingdoms. Mr. Michael Gunn has recently determined to carry out a very extensive series of improvements, amongst which the complete fitting of the electric light stood foremost. This has been very successfully carried out within four weeks' time, under the supervision of Mr. Harry South, who was engaged by Mr. Gunn for that purpose, and several of his special stage appliances were introduced. The interior is hung with handsome electroliers, fitted with delicately tinted glass flower bulbs. The construction of the entire and complex plant was entrusted to the Electrical Engineering Company of Ireland, and was carried out under their chief engineer, Mr. Porte. Behind the stage entrance is the engine-house, where two Otto gas engines (14-h.p. each) have been erected by Messrs. Crossley and Co., of Manchester. These engines have been specially designed for electric lighting purposes, and are the first of their kind that have been sent to Ireland. They drive two compound wound dynamos built by Messrs. Laurence and Scott, of Norwich. Both engines and dynamos were specially constructed for this contract, and either set is capable of lighting all the lamps that will be in use at one time. The dynamos are driven by cotton ropes. The engine-house also contains very complete switching arrangements, which enable the load to be thrown at an instant's notice from one engine and dynamo to the other without a break, not a flicker being apparent in the 250 lamps of the installation. The roof above presents a curious appearance. It is covered by a network of wires communicating with a switch-board at the side of the stage, which is provided with a series of levers governing the entire lighting system of the house, and with indicators which show the pressure and quantity of the current. From this point the lights employed for all stage effects are controlled. Resistances have been arranged so that it is possible to lower the lamps in different degrees from full power to a mere glow, and the turn of a handle upon a circular plate reduces the number of footlights, so that any conceivable quality of illumination is producible at will. To this part of the installation Mr. Gunn, who is himself an electrician of some experience in connection with the lighting of the Savoy, has given particular attention, and the system is considered as perfect as it is possible for modern scientific skill to render it. The whole of the work reflects the highest credit upon those engaged in it. The machinery had to be built, the switching arrangements designed and made, and the entire plant perfectly fitted in three weeks after the order was received. All hands worked night and day and no labour was spared. The trial on Saturday was a great success.

They are stated by the makers to read accurately on non-nductive resistances, and on inductive circuits in which the roduct of the pressure and current is 50 times the real ower.

The wattmeter has the advantage over electrometer ethods, that it does not involve the very serious troubles ver resistances. Mr. Swinburne recently described an lectrometer which reads power directly, which, though it oes the work of the three voltmeters discussed by Messrs. yrton, Sumpner, and Swinburne soon after, unfortunately requires resistances. Dr. Fleming has enormously improved the three-instrument method by substituting amperemeters, and we thus have unimpeachable means of verifying the wattmeter. If this wattmeter does what the makers claim for it, it will be exceedingly valuable to alternating-current engineers.



EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

(Continued from page 131.)

With these rapidly alternating potentials there is, however, no necessity of enclosing two blocks in a globe, but a single block, as in Fig. 20, or filament, Fig. 23, may be used. The potential in this case must of course be higher, but it is easily obtainable, and besides it is not necessarily dangerous.

The facility with which the button or filament in such a lamp is brought to incandescence, other things being equal, depends on the size of the globe. If a perfect vacuum could be obtained, the size of the globe would not be of importance, for then the heating would be wholly due to the surging of the charges, and all the energy would be given off to the surroundings by radiation. But this can never occur in practice. There is always some gas left in the globe, and although the exhaustion may be carried to the highest degree, still the space inside of the bulb must be considered as conducting when such high potentials are used, and I assume that in estimating the energy that may be given off from the filament to the surroundings we may consider the inside surface of the bulb as one coating of a condenser, the air and other objects surrounding the bulb forming the other coating. When the alternations are very low there is no doubt that a considerable portion of the energy is given off by the electrification of the surrounding air.

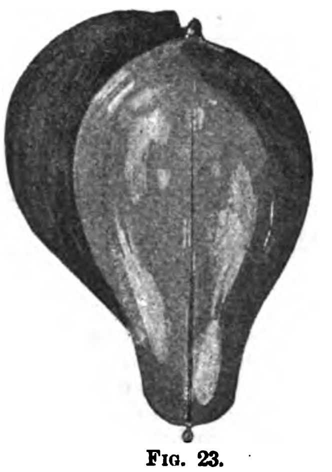


Fig. 23.

In order to study this subject better, I carried on some experiments with excessively high potentials and low frequencies. I then observed that when the hand is approached to the bulb—the filament being connected with one terminal of the coil—a powerful vibration is felt, being due to the attraction and repulsion of the molecules of the air which are electrified by induction through the glass. In some cases where the action is very intense I have been able to hear a sound, which must be due to the same cause.

When the alternations are low, one is apt to get an excessively powerful shock from the bulb. In general, when one attaches bulbs or objects of some size to the terminals of the coil, one should look out for the rise of potential, for it may happen that by merely connecting a bulb or plate to the terminal, the potential may rise to many times its original value. When lamps are attached to the terminals, as illustrated in Fig. 24, then the capacity of the bulbs should be such as to give the maximum rise of potential under the existing conditions. In this manner one may obtain the required potential with fewer turns of wire.

The life of such lamps as described above depends, of course, largely on the degree of exhaustion, but to some extent also on the shape of the block of refractory material. Theoretically it would seem that a small sphere of carbon enclosed in a sphere of glass would not suffer deterioration from molecular bombardment, for, the matter in the globe being radiant, the molecules would move in straight lines, and would seldom strike the sphere obliquely. An interesting thought in connection with such a lamp is, that in it "electricity" and electrical energy apparently must move in the same lines.

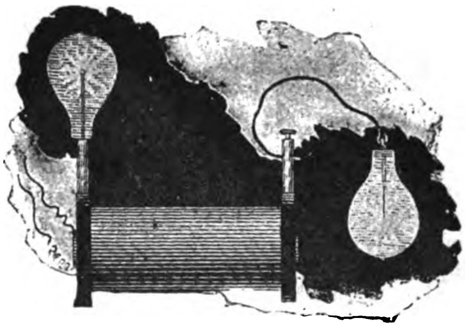


Fig. 24.

The use of alternating currents of very high frequency makes it possible to transfer, by electrostatic or electromagnetic induction through the glass of a lamp, sufficient energy to keep a filament at incandescence and so do away with the leading-in wires. Such lamps have been proposed, but for want of proper apparatus they have not been successfully operated. Many forms of lamps on this principle, with continuous and broken filaments, have been constructed by me and experimented upon. When using a secondary enclosed within the lamp, a condenser is advantageously combined with the secondary. When the transference is effected by electrostatic induction, the potentials used are, of course, very high with frequencies obtainable from a machine. For instance, with a condenser surface of 40 centimetres square, which is not impracticably large, and with glass of good quality 1 mm. thick, using currents alternating 20,000 times a second, the potential required is approximately 9,000 volts. This may seem large, but since each lamp may be included in the secondary of a transformer of very small dimensions, it would not be inconvenient, and, moreover, it w roduce fatal injury. The transformers would a y in series. The regulation would offer no diffi currents ried before, and their receipts increased from these stations ne 50 per cent. Whether the development of this policy—reasing the fares at other stations—would produce like results s a question they had to consider very carefully. It was not the interests of the Company to reduce fares. They regretted have to alter the plan of a perfect uniformity of fare over the e. They thought they should adjust their ideas to the circumnces of the time, however, and increase the popularity of the e and its resultant receipts. They agreed to go to Parliament an extension of that line from the City up to The Angel at Islingn. That would have been a very good line in itself, and would, thought, have paid very well, as well as bringing to the existing e a very considerable increase of traffic exactly at the time of y they wanted it. Unfortunately circumstances occurred in the st Committee of the House of Commons which led them to row out the Bill. There was very slight opposition, the only maining opponents at last being the Corporation of London, and en they, he believed, did not wish that the Bill should be thrown t. They (the Board) had nothing to do with the circumstances hich arose. It was very doubtful whether in their present ancial position the Board would come to the shareholders again ith a recommendation to go for that extension, because until ey had brought up the price of their shares in the market, it as doubtful whether they could obtain the necessary capital. etween this and next session they would have to consider the estion, and if they could see their way to carry it out ithout burdening the existing company, they would prefer to o so. The new plant they were putting down was intended as art of that which would ultimately work the Clapham extension, ut the same reason which prevented their going for the Islington ne applied to the Clapham one. They would see from the report hat the action taken by the County Council—which was a very rbitrary one on the part of that Council, who really had no good ase as regarded that Company, the real object being the testing f particular rates which they thought they could try upon a small ompany better than a large one—had been successfully opposed y the Company in the first courts, and the result affirmed in their avour in the Appeal Court. Having nothing further to add, he ould move that the report and accounts be approved and dopted.

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* Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

This was seconded by **Mr. Hanbury**.

Mr. Peto was glad to hear the Chairman say they were not oing to proceed with the Islington extension. They would not ose anything by waiting to see what would be the result of working he old line. He noticed that they had elected another gentleman o the Board in the place of Mr. Robinson, resigned. He asked, ooking at the fact that the railway was a very small matter, was t absolutely necessary to have five directors? He did not want hem to work for nothing, but it seemed to him that three would e ample. Adverting to the wages and salaries, he asked whether he work of manager and secretary could not be done by one entleman.

The **Chairman** said that, unfortunately, they were bound by their Act of Parliament to have five directors, and, moreover, they could not do with less, as three formed a quorum. Though the income of the Company looked small at present, the work connected with it was by no means small. This was a railway that required a very great deal of constant attention and management. They could not do without an efficient staff at their headquarters. They must remember that the number of passengers carried was very large, and the number of trains and the length of time they were run exceptionally so. They were therefore obliged to duplicate the staff in many cases. The latter was therefore necessarily larger than was absolutely proportionate to the traffic. The relative expenses on this head would diminish as the traffic increased, because it would not be necessary to increase the staff. As to the appointment of Mr. Heward as Director in place of Mr. Robinson, that gentleman represented very large shareholding interests in the Company, and had given them the benefit of his advice at the Board for a long time, and had acquired considerable knowledge of the Company's affairs. They thought, therefore, they could not do better than ask him to take a seat at the Board. The Chairman then put the resolution, which was carried unanimously.

The proceedings closed with the usual vote of thanks to the Chairman.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

The half-yearly meeting of this Company was held in Liverpool on Tuesday, Sir Wm. B. Forwood presiding. The report is alluded to in our "Notes."

The **Chairman** referred to the progress of the works during the past half-year, and said he was pleased to say that they had made satisfactory progress indeed. The main structure had advanced south to the Collingwood Dock, in the course of which three important opening bridges had been constructed. The foundations were completed as far south as St. Nicholas Church, and they expected the main structure would be advanced to that point by the end of September or the beginning of October. During the past six months they had erected two miles of the main structure, and the contractor expected that the whole of the foundation for the southern section would be completed within four months. It was somewhat rash to hazard an opinion as to when it would be completed, but he hoped that the forecast which he gave at the last meeting would be realised, and that when the shareholders met again next spring they would be within measurable distance of the completion of their important undertaking. The position of the line on the southern section would be changed somewhat from what it was originally proposed to be. The original plan was to elevate it along the Wapping Dock and warehouses, but by the liberality of the Corporation of Liverpool and the Dock Board they would now be able to keep on the same level all through. That was very important for the successful working of the railway. During the past six months the Directors had given serious consideration to the means of propulsion to be employed, and they had visited various electrical works in the country, including the electric railway now working in London. They had had the advantage of the advice of Mr. Greathead, the engineer of the railway running under the Thames, and after carefully considering the subject, they had decided to adopt electricity, because it would be safer, cleaner, and more economical in its working. Tenders were then invited from the principal manufacturers of electrical machinery, and the Directors had accepted the tender of the Electric Construction Corporation, of Wolverhampton. The electricity would be generated at a central station, to be located near the Wellington Dock, a position which they had been fortunate enough to obtain from the Dock Board. By having their station at that point they could obtain water at an advantage, and they would also have the advantage of having their coal tipped from the railway overhead, without the necessity of constructing buildings, etc. In that way they would save a considerable amount of money. The electricity would be conveyed by a central rail to the motor cars which will compose the train. The journey from end to end, including stoppages, would be made in 25 minutes. In order to safeguard the shareholders as much as possible from the many contingencies which beset railways, a contract was made with the Electric Construction Corporation for working the train at a fixed price per train mile for two years. That in itself was a guarantee that they would work it safely, and at the same time give the best possible machinery. He was sure they would be gratified at the progress of the works. They had had their difficulties, but he was glad to be able to say that these had been surmounted, and now he hoped that there would be no further obstacle to the work progressing with great rapidity, and he really thought that at the next meeting of the shareholders they would be within very near distance of the completion of the railway. With these remarks he begged to move the adoption of the report.

Mr. J. B. Brancker seconded the motion, and it was carried unanimously.

Replying to various questions, the **Chairman** said that the main structure had now been advanced to the Clarence Dock, and the Company had decided to have first and second classes. Fares had not yet been resolved upon. The 3½d. per train mile covered the whole of what were known as the locomotive expenses of the line. It had been the intention of the Directors from the first to open the northern section as soon as it was completed; but a great deal would depend upon the completion of their electrical plant and generating station. In other words, the southern section was being proceeded with so rapidly that it might be completed by the time the electrical equipment was ready, and in that case all sections of the line would be opened together. The Directors did not at present contemplate manufacturing electricity for illuminating purposes, except for their own uses. The line would be lighted by electricity manufactured by themselves, but if they went beyond that they would require a far larger area for generating plant, and they must bring their own business to a state of efficiency before they attempted anything in that direction.

UNITED RIVER PLATE TELEPHONE COMPANY.

The fifth ordinary general meeting of this Company was held on Friday, 7th inst., at Winchester House, Mr. J. Irving Courtenay presiding.

The **Chairman** said the results of the past year's working of the Company had been entirely governed by one factor—the gold premium. The gross income for the past financial year had been £106,259, as compared with £108,612 in the previous year, the difference arising solely from the diminution of their sales business, which, in consideration of the long credits customary in the River Plate, they had not thought it prudent to push. More money had been received from subscribers and messages in the year under review than in the previous year, although there had been a considerable falling off in the total number of their subscribers. No fewer than 1,099 new subscribers came on their books during last year, and he believed they would find their experience to be the same as had been found in other enterprises—that the subscribers who came on during a period of financial tightness were more permanent subscribers and were better payers than those who came on during a period of inflated commercial prosperity. Their working expenses in the River Plate had been £56,941, a reduction of £6,566 compared with those of the previous year. This reduction of 10 per cent. had been the result of economies, notwithstanding the increased cost, to a considerable extent, of materials, general expenses, and taxes. Further economies to some extent were anticipated, but unless a reduction occurred in the gold premium a greater degree of expenditure must be expected. This would necessitate such a rise in their rates as would at least meet the increased expenditure. He regretted that the Directors were unable, for the first time in the Company's history, to declare a dividend. This was entirely owing to their loss on exchange, which had amounted to £36,049, or nearly 12½ per cent. on the Company's paid-up capital. With only a slight revival of commercial affairs in Buenos Ayres and a fall in the gold premium, the Company would soon again be in a dividend-paying condition. Telegraphic advices from Buenos Ayres, dated the 4th inst., stated that their receipts for July had been better than those for the same month of last year. The report and accounts were adopted.

NOTES.

Portraits.—The *Electrical World* for August 8 contains a speaking likeness of Mr. W. M. Mordey.

Omagh.—The Town Commissioners of Omagh are desirous of having particulars of the cost of lighting the town by electricity.

Power from Niagara.—It is proposed to transmit power electrically all the way from Niagara Falls to the forthcoming Chicago Exhibition.

Lisburn (Ireland).—The gas company of Lisburn have advanced the price of public lighting. The authorities are considering the question of electric light.

Fleetwood.—At the last meeting of the Fleetwood Improvement Commissioners the correspondence upon electric lighting was left over till next meeting.

Chertsey.—The gas lighting of Chertsey has been settled for this year at £3. 3s. per lamp. The question of considerable extension to Addlestone is to be considered next year.

Telephone at Clitheroe.—The Clitheroe Watch Committee refused to take any part in the connection of the police office with the workhouse by telephone as proposed by the Board of Guardians.

Nomenclature.—Confusion—we mean no joke—is often experienced between a fuse and a fuse; that is, between a fusible strip, and a box with terminals to contain it. It is proposed to call the former "fuse links."

Sophia.—Premiums of 10,000, 7,000, and 5,000 francs will be awarded by the authorities of Sophia for schemes of lighting that town, the said schemes to remain the property of the town. The plans will be opened on 28th December, 1891.

Felstead School.—A complete installation is being erected for the lighting of Felstead School by Messrs. Drake and Gorham. The lighting is being extended, not only to the school, but to the chapel, gymnasium, infirmary, and other outbuildings.

Brazil.—A sample electric railway installation has been sent to Brazil from the United States, consisting of one car with 25-h.p. motors, a 50,000 watt generator, and entire equipment for a 1½-mile track. If successful, complete plant for 60 cars will be required.

Bewdley.—The Bewdley Watch and Lighting Committee reported that the offer of the gas company to light the public lamps for the eight months from September 1st at £2. 10s. a lamp had not been accepted by the committee, which hoped to make more favourable terms.

Electric Advertising.—The whitewashed walls of tunnels are used in Chicago in a novel advertisement. On the centre of the roof is a wire placard, arranged in such a way that the glare from the electric light casts huge shadowed letters on the wall. Enterprising advertisers may note.

Central Station Arrangement.—We notice that a work on central stations, by M. G. P. Anney, entitled "Manuel Pratique de l'Installation de la Lumière Electrique, Stations Centrales," has been published in Paris (B. Tignol, 53, Quai des Grands Augustins, Paris, 7f.), with 99 figures and 10 plates.

Lynton.—The Devon Electric Lighting Company intend to apply to the Board of Trade for a provisional order to supply electric lighting to Lynton and Lynmouth. The application will be made in November. Ventilation shafts have been affixed to the present electric lighting plant, and other improvements are being made.

Electric Lighting in Ireland.—The seaport of Larne has been lighted by electricity. This is the first town in the North of Ireland which has adopted the new light. This installation, like that of Carlow, has been carried out by Messrs. J. E. H. Gordon and Co.

Dover.—At the last meeting of the Managing Committee of the Dover Town Council, a letter was read from the Brush Company, stating that the letter of the Council's *re* electric light was under consideration, but that time was required to give a satisfactory answer; and also that one of the company's engineers was about to visit Dover and report.

Bahia.—We notice that the *Moniteur Industriel* (Aug. 13) gives particulars of a contract invited by the State of Bahia, Brazil, for public lighting—no system mentioned—from the 9th May, 1892, the contract with the Bahia Gas Company expiring at this date. The contracts are to be in the hands of the secretary, Manoel Pedro de Rezende, Bahia, by 30th of this month.

Alternate-Current Motors.—Readers of the patents column may see that two specifications were accepted last week for alternate-current motors, one being the complete specification of Dolivo-Dobrowolski, and the other a motor invented by Mr. Arthur Arnot, of Australia, which we mentioned a few weeks ago. There is also an improved generator for multi-phase currents.

Sydenham.—A new company has been brought out this week, the Electric Installation and Maintenance Company, for the supply of electricity to the Crystal Palace and the district of Sydenham. The capital is £100,000 in £10 shares, of which Messrs. J. E. H. Gordon and Co., who are contractors to the company, are to take over a thousand as part payment of plant.

Liverpool.—The Liverpool Electric Company have objected to certain charges made by the Liverpool Corporation for the repair of roads. It was stated at the meeting of the Health Committee that the Corporation were on the safe side, as the company had deposited £500, from which the amount could be deducted. If a dispute arose, the Board of Trade would arbitrate.

Barnsley.—At the last meeting of the Barnsley Town Council, the minutes were read of the Park and Lighting Committee meeting held July 31. The borough surveyor laid before the committee a scheme and plan prepared by him for the supply of electricity to a smaller area than the one referred to in the Barnsley Electric Lighting Order, and the committee adjourned the consideration thereof until their next meeting. The minutes were confirmed.

Glasgow.—At the Glasgow Town Council meeting last week, it was stated that at the meeting of the Gas Committee it was decided to take the advice of Sir William Thomson with regard to various matters which had recently cropped up, and which were of vital importance to the question of the electric lighting of Glasgow. Under the circumstances, Councillor Colquhoun agreed to delay for a month the motion standing in his name with reference to electric light.

Collodion in Electroplating.—In a recent patent, Herr Falk, of Berlin, claims the use of photographic collodion as a conducting layer to be applied upon the body to be plated. After drying and exposing to the light the silver salts are reduced by the sulphate of iron, and produces a metallic surface. This process is often described in lectures on physics, and has been employed more particularly, it is said, for some time back to the plating of flowers and insects.

Electric Cure for Sciatica.—A correspondent of a medical paper says that if the positive pole of a galvanic the current. This is one of the most delicate of all the perations to be carried out on a central distributing system. t the places where the cables from the customers' houses e joined to the distributing mains it is usual to enclose e junctions within cast-iron chambers, termed service-oxes.

Figs. 21 and 22 allow the operations to be understood. he connection between two cables is made by a piece of opper (Fig. 22) having two collars between two clamps, of hich the extremities of the cables to be connected are ripped by means of two bolts or screws. The conductors, and N, which it is desired to attach to the branches, P nd Q, are bared for a short length, *m*, *n*, *p*, and *q*. These arts are gripped by the connectors and screwed up tightly, fter which an insulating substance is poured in, filling p the lower part of the cast-iron box—which, in most ases, is in two parts—and then the whole chamber is closed y a screw-down lid.

The service mains coming laterally from the box pass hrough a sort of stuffing-box (Fig. 26). In this latter gure, the lateral wall is represented at A; a truncated pening is formed therein, into which is introduced an india-ubber plug, B, compressed by a screw-plate, C.

Figs. 23 to 26 show the various forms of boxes, the contruction of which is all upon the same principle. Every recaution is taken to ensure perfect watertightness in all he different parts.

(To be continued.)

XPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

(*Concluded from page* 161).

The ideal way of lighting a hall or room, would, however, be to produce such a condition in it that an illuminating device could be moved and put anywhere, and that it is lighted, no matter where it is put, and without being electrically connected to anything. I have been able to produce such a condition by creating in the room a powerful, rapidly alternating electrostatic field. For this purpose I suspend a sheet of metal a distance from the ceiling on insulating cords and connect it to one terminal of the induction coil, the other terminal being preferably connected to the ground. Or else I suspend two sheets as illustrated in Fig. 30, each sheet being connected with one of the terminals of the coil, and their size being carefully determined. An exhausted tube may then be carried in the hand anywhere between the sheets or placed anywhere, even a certain distance beyond them; it remains always luminous.

In such an electrostatic field interesting phenomena may be observed, especially if the alternations are kept low and the potentials excessively high. In addition to the luminous phenomena mentioned, one may observe that any insulated conductor gives sparks when the hand or another object is approached to it, and the sparks may often be powerful. When a large conducting object is fastened on an insulating support, and the hand approached to it, a vibration, due to the rythmical motion of the air molecules, is felt, and luminous streams may be perceived when the hand is held near a pointed projection. When a telephone receiver is made to touch with one or both of its terminals an insulated conductor of some size, the telephone emits a loud sound; it also emits a sound when a length of wire is attached to one or both terminals, and with very powerful fields a sound may be perceived even without any wire.

How far this principle is capable of practical application the future will tell. It might be thought that electrostatic effects are unsuited for such action at a distance. Electromagnetic inductive effects, if available for the production of light, might be thought better suited. It is true the electrostatic effects diminish nearly with the cube of the distance from the coil, whereas the electromagnetic inductive effects diminish simply with the distance. But when we establish an electrostatic field of force, the condition is very different, for then, instead of the differential effect of both the terminals, we get their cojoint effect. Besides, I would call attention to the fact, that in an alternating electrostatic field, a conductor, such as an exhausted tube for instance, tends to take up most of the energy, whereas, in an an electromagnetic alternating field the conductor tends to take up the least energy, the waves being reflected with but little loss. This is one reason why it is difficult to excite an exhausted tube, at a distance, by electromagnetic induction. I have wound coils of very large diameter and of many turns of wire, and connected a Geissler tube to the ends of the coil with the object of exciting the tube at a distance; but even with the powerful inductive effects producible by Leyden jar discharges, the tube could not be excited unless at a very small distance, although some judgment was used as to the dimensions of the coil. I have also found that even the most powerful Leyden jar discharges are capable of exciting only feeble luminous effects in a closed exhausted tube, and even these effects upon thorough examination I have been forced to consider of an electrostatic nature.

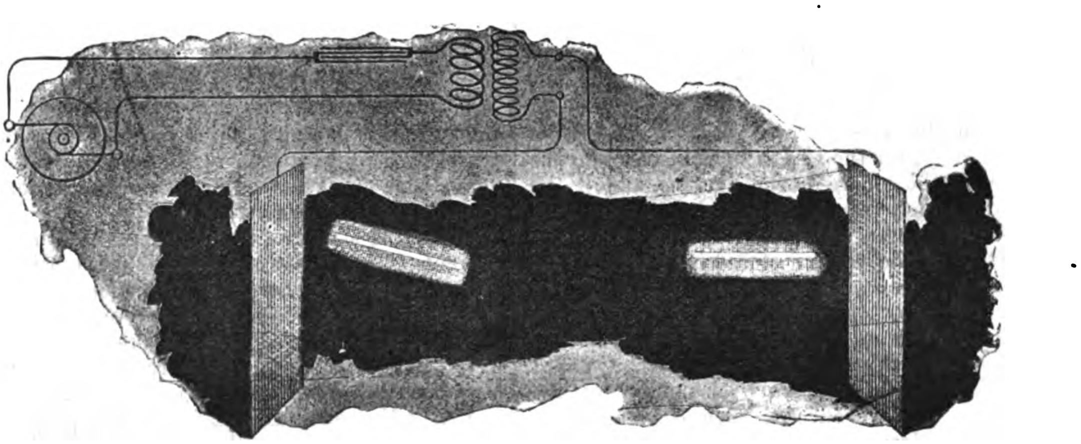

FIG. 30.

How, then, can we hope to produce the required effects at a distance by means of electromagnetic action, when even in the closest proximity to the source of disturbance, under the most advantageous conditions, we can excite but faint luminosity? It is true that when acting at a distance we have the resonance to help us out. We can connect an exhausted tube, or whatever the illuminating device may be, with an insulated system of the proper capacity, and so it may be possible to increase the effect qualitatively, and only qualitatively, for we would not get more energy through the device. So we may by resonance effect obtain the required E.M.F. in an exhausted tube, and excite faint luminous effects, but we cannot get enough energy to render the light practically available, and a simple calculation, based on experimental results, shows that even if all the energy which a tube would receive at a certain distance from the source should be wholly converted into light, it would hardly satisfy the practical requirements. Hence the

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[*] Lecture delivered before the American Institute of Electrical Engineers at Columbia College, New York, May 20.

g. 33, and shunted by ordinary incandescent lamps, then, r passing the discharge between the knobs, the lamps may brought to incandescence although they are short-rcuited. When a large induction coil is employed it is sy to obtain nodes on the bar, which are rendered ident by the different degree of brilliancy of the lamps, shown roughly in Fig. 33. The nodes are never clearly efined, but there are simply maxima and minima of otentials along the bar. This is probably due to the regularity of the arc between the knobs. In general when e above described plan of conversion from high to low nsion is used, the behaviour of the disruptive discharge ay be closely studied. The nodes may also be investi-ted by means of an ordinary Cardew voltmeter which ould be well insulated. Geissler tubes may also be lighted ross the points of the bent bar; in this case, of course, it is etter to employ smaller capacities. I have found it prac-cable to light up in this manner a lamp, and even a eissler tube, shunted by a short heavy block of metal, and is result seems at first very curious. In fact, the thicker e copper bar in Fig. 33, the better it is for the success of e experiments, as they appear more striking. When mps with long slender filaments are used it will be often oted that the filaments are from time to time violently ibrated, the vibration being smallest at the nodal points. his vibration seems to be due to an electrostatic action etween the filament and the glass of the bulb.

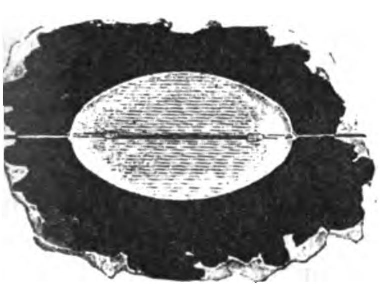

FIG. 34.

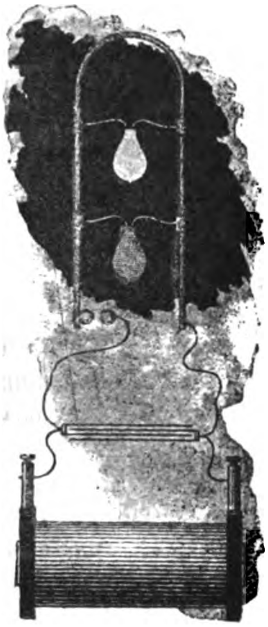

FIG. 33.

In some of the above experiments it is preferable to use special lamps having a straight filament, as shown in Fig 34. When such a lamp is used a still more curious phenomenon than those described may be observed. The lamp may be placed across the copper bar and lighted, and by using somewhat larger capacities, or, in other words, smaller frequencies, or smaller impulsive impedancies, the filament may be brought to any desired degree of incandescence. But when the impedance is increased a point is reached when comparatively little current passes through the carbon, and most of it through the rarified gas; or perhaps it may be more correct to state that the current divides nearly evenly through both, in spite of the enormous difference in the resistance, and this would be true unless the gas and the filament behave differently. It is then noted that the whole bulb is brilliantly illuminated, and the ends of the leading-in wires become incandescent and often throw off sparks in consequence of the violent bombardment, but the carbon filament remains dark. This is illustrated in Fig. 34. Instead of the filament a single wire extending through the the whole bulb may be used, and in this case the phenomenon would seem to be still more interesting.

From the above experiment it will be evident that when ordinary lamps are operated by the converted currents, those should be preferably taken in which the platinum wires are far apart, and the frequencies used should not be too great, else the discharge will occur at the ends of the filament or in the base of the lamp between the leading-in wires, and the lamp might then be damaged.

In presenting to you these results of my investigation on the subject under consideration, I have paid only a passing notice to facts upon which I could have dwelt at length, and among many observations I have selected only those which I thought most likely to interest you. The field is wide and completely unexplored, and at every step a new truth is gleaned, a novel fact observed.

How far the results here borne out are capable of practical applications will be decided in the future. As regards the production of light, some results already reached are encouraging, and make me confident in asserting that the practical solution of the problem lies in the direction I have endeavoured to indicate. Still, whatever may be the immediate outcome of these experiments, I am hopeful that they will only prove a step to further development towards the ideal and final perfection. The possibilities which are opened by modern research are so vast that even the most reserved must feel sanguine of the future. Eminent scientists consider the problem of utilising one kind of radiation without the others a rational one. In an apparatus designed for the production of light by conversion from any form of energy into that of light, such a result can never be reached, for no matter what the process of producing the required vibrations, be it electrical, chemical, or any other, it will not be possible to obtain the higher light vibrations without going through the lower heat vibrations. It is the problem of imparting to a body a certain velocity without passing through all lower velocities. But there is a possibility of obtaining energy not only in the form of light, but motive power, and energy of any other form, in some more direct way from the medium. The time will be when this will be accomplished, and the time has come when one may utter such words before an enlightened audience without being considered a visionary. We are whirling through endless space with an inconceivable speed, all around us everything is spinning, everything is moving, everywhere is energy. There must be some way of availing ourselves of this energy more directly. Then, with the light obtained from the medium, with the power derived from it, with every form of energy obtained without effort, from the store forever inexhaustible, humanity will advance with giant strides. The mere contemplation of these magnificent possibilities expands our minds, strengthens our hopes, and fills our hearts with supreme delight.

GODMANCHESTER.

The following comparative statement of the advantages and relative cost of electric light and gas from Messrs. Ernest Scott and Co., Newcastle-on-Tyne, was read by the clerk at the last meeting of the Godmanchester Town Council:

Electric light.—250 lamps of 16 c.p., 1,000 hours.

	£	s.	d.
Coal for 25 h.p., 1,000 hours, at 2¼lb. per i.h.p. per hour, 28 tons at 8s.	11	4	0
Oil per week at 2s. 6d.	6	10	0
Sundries at 2s. 6d.	6	10	0
Lamp renewals, 250 lamps at 3s. 9d.	46	17	6
	71	1	6
Add 10 per cent. interest and depreciation on plant, say £400	40	0	0
	£111	1	6

Gas.—250 burners, 6ft. per hour, 1,000 hours.

	£	s.	d.
Cost of gas consumed, 1,500,000ft. at 2s. 6d. per 1,000ft.	187	10	0
Cost of replacing burners and repairs, 5s. per week	13	0	0
	200	10	0
Add 5 per cent. interest on capital expended on fittings, on say £150	7	10	0
	£208	0	0

ure of 50 volts to give a current of 1,400 amperes. To the difficulties of contacts with such an enormous nt, the armature is made stationary, and the field nets revolve. The conductors in the armature are illimetres in diameter, and consist of massive copper , insulated by being slipped inside asbestos tubes, and ted into holes punched out of the iron periphery. ucault currents, which would rise to enormous amounts such large conductors if arranged in the ordinary way, , by this arrangement, avoided, and, in fact, tests made th these buried conductors even up to 50 millimetres ameter did not show any loss by Foucault currents. This device is mechanically strong, and as asbestos can be used as insulation, an absolutely incombustible armature is obtained. Besides these advantages, the lesser air space required, with consequent reduction of magnetic resistance, enables the exciting current to be considerably decreased.

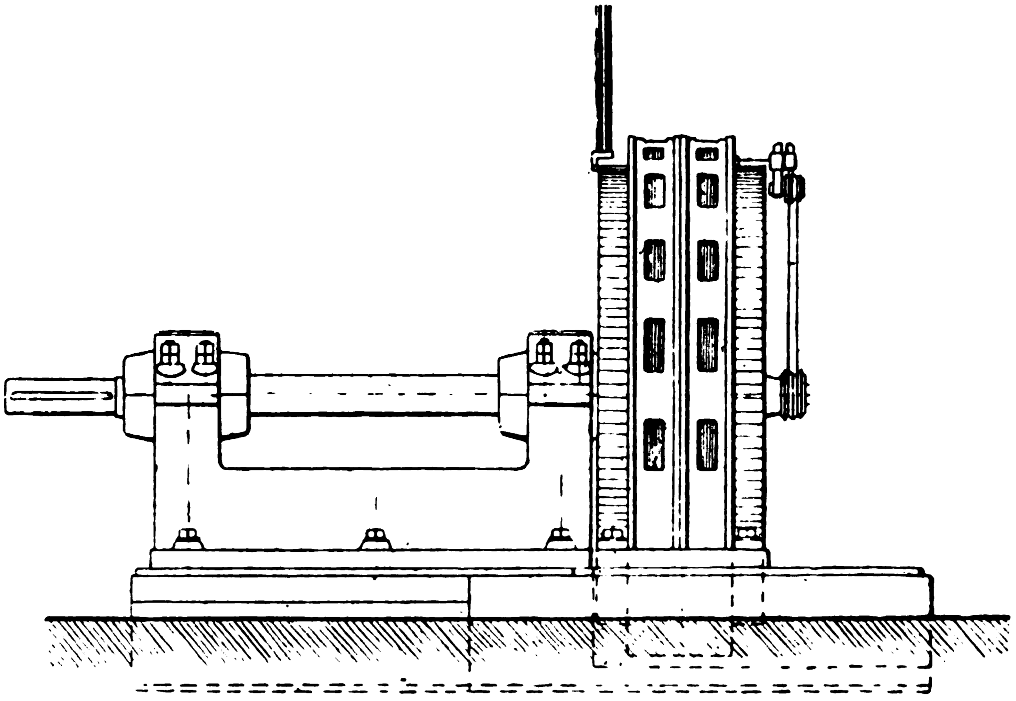

FIG. 3.—Section of Oerlikon Dynamo.

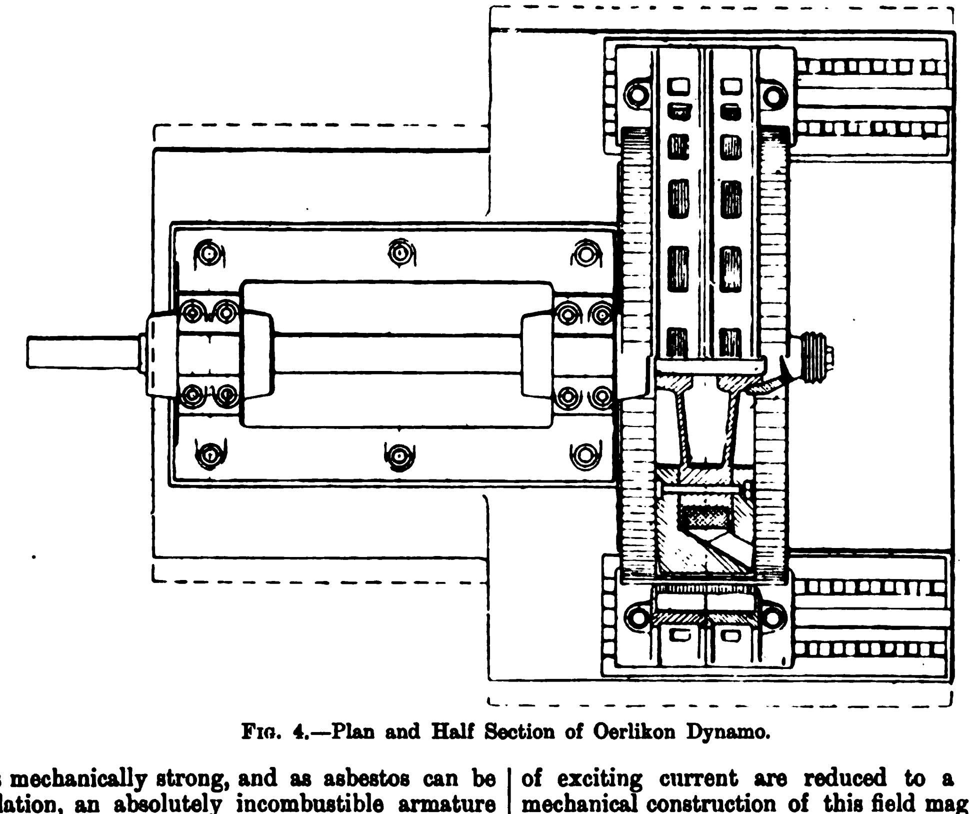

FIG. 4.—Plan and Half Section of Oerlikon Dynamo.

The field magnets have 32 poles, and correspondingly each circuit of the armature has 32 copper bars, all in series. There being three circuits, there are in all 96 bars on the armature. These three circuits are connected up to each other in the method familiar to electrical engineers in the Thomson-Houston arc dynamo. The core of the armature is surrounded by a frame of cast iron, and the whole can be moved along the bed-plate for repair or cleaning, leaving the field magnet exposed (see Fig. 2).

The exciting coils are wound upon a kind of iron wheel, two steel rims, each having 16 projecting teeth forming pole-pieces, are bolted to this pulley, one on each side. This arrangement permits the maximum utilisation of the magnetism, and both the weight of copper and the amount of exciting current are reduced to a minimum. The mechanical construction of this field magnet is simple, the 32 poles being in four parts only—an extreme advantage in a moving mass subject to great strains. The details of the dynamo are shown in plan, section, and elevation in Figs. 3, 4, and 5.

The exciting current is led to the field magnets by two wide outlook is wholesome, and that without such occasional survey the rigid attention to detail and minute scrutiny of every little fact which are so entirely admirable and are so rightly here fostered, are apt to become unhealthily dull and monotonous. Our life-work is concerned with the rigid framework of facts, the skeleton or outline map of the universe; and, though it is well for us occasionally to remember that the texture and colour and beauty which we habitually ignore are not therefore in the slightest degree non-existent, yet it is safest speedily to return to our base and continue the slow and laborious march with which we are familiar and which experience has justified. It is because I imagine that such systematic advance is now beginning to be possible in a fresh and unexpected direction that I have attempted to direct your attention to a subject which, if my prognostications are correct, may turn out to be one of special and peculiar interest to humanity.

THE LONDON-PARIS TELEPHONE.*

BY W. H. PREECE, F.R.S.

1. I have already on two occasions, at Newcastle and at Leeds, brought this subject before Section G, and have given the details of the length and construction of the proposed circuit. I have now to report not only that the line has been constructed and opened to the public, but that its success, telephonic and commercial, has exceeded the most sanguine anticipations. Speech has been maintained with perfect clearness and accuracy. The line has proved to be much better than it ought to have been, and the purpose of this paper is to show the reason why.

The lengths of the different sections of the circuit are as follows:

London to St. Margaret's Bay	84·5	miles.
St. Margaret's Bay to Sangatte (cable)	23·	,,
Sangatte to Paris	199·	,,
Paris underground	4·8	,,
Total	311·3	,,

The resistances are as follows:

Paris underground	70	ohms.
French line	294	,,
Cable	143	,,
English line	183	,,
Total (R)	693	,,

The capacities are as follows:

Paris underground	0·43	microfarads.
French line	3·33	,,
Cable	5·52	,,
English line	1·32	,,
Total (K)	10·62	,,

$$693 \times 10{\cdot}62 = 7{,}359 = K\,R,$$

a product which indicates that speech should be very good.

2. *Trials of Apparatus.*—The preliminary trials were made during the month of March between the chief telegraph offices of the two capitals, and the following microphone transmitters were compared:

Ader	Pencil form.
Berliner	Granular ,,
D'Arsonval	Pencil ,,
De Jongh	,, ,,
Gower-Bell	,, ,,
Post Office switch instrument	Granules and lamp filaments.
Roulez	Lamp filaments.
Turnbull	Pencil form.
Western Electric	Granular.

The receivers consisted of the latest form of double-pole Bell telephones with some Ader and D'Arsonval receivers for comparison. After repeated trials it was finally decided that the Ader, D'Arsonval, Gower-Bell (with double-pole receivers instead of tubes), Roulez, and Western Electric were the best, and were approximately equal.

These instruments were, therefore, selected for the further experiments, which consisted of using local extensions in Paris and London. The wires were in the first instance extended at the Paris end to the Observatory through an exchange at the Avenue des Gobelines. The length of this local line is 7 kms. The wires are guttapercha covered, placed underground, and not suitable for giving the best results.

The results were, however, fairly satisfactory. The wires were extended to the Treasury in London by means of the ordinary underground system. The distance is about two miles, and although the volume of sound and clearness of articulation were perceptibly reduced by these additions to the circuit, conversation was quite practicable.

Further trials were also made from the Avenue des Gobelines on underground wires of five kilometres long, and also with some renters in Paris with fairly satisfactory results. The selected telephones were equally efficient in all cases, which proves that to maintain easy conversation when the trunk wires are extended to local points it is only necessary that the local lines shall be of a standard not lower than that of the trunk line. The experiments also confirm the conclusion that long-distance speaking is solely a question of the circuit and its environments, and not one of apparatus. The instruments finally selected for actual work were Gower-Bell for London and Roulez for Paris.

3. The results are certainly most satisfactory. There is no circuit in or out of London on which speech is more perfect than it is between London and Paris. In fact, it is better than I anticipated, and better than calculation led me to expect. Speech has been possible not only to Paris but through Paris to Bruxelles, and even, with difficulty, through Paris to Marseilles, a distance of over 900 miles. The wires between Paris and Marseilles are massive copper wires specially erected for telephone business between those important places.

4. *Business Done.*—The charge for a conversation between London and Paris is 8s. for three minutes' complete use of the wire. The demand for the wire is very considerable. The average number of talks per day, exclusive of Sunday, is 86. The maximum has been 108. We have had as many calls as 19 per hour—the average is 15 during the busy hours of the day. As an instance of what can be done 150 words per minute have been dictated in Paris and transcribed in London by shorthand writing. Thus in three minutes 450 words were recorded, which at 8s. cost five words for a penny.

5. *Difficulties.* — The difficulties met with in long-distance speaking are several, and they may be divided into (*a*) those due to external disturbances and (*b*) those due to internal opposition.

(*a*.) Every current rising and falling in the neighbourhood of a telephone line within a region, say, of 100 yards, whether the wire conveying it be underground or overground, induces in the telephone circuit another current, producing in the telephone a sound which disturbs speech, and if the neighbouring wires are numerous and busy, as they are on our roads and railways, these sounds become confusing, noisy, and ultimately entirely preventative of speech. This disturbance is, however, completely removed by forming the telephone circuit of two wires placed as near to each other as possible, and twisted around each other without touching, so as to maintain the mean average distance of each wire from surrounding conductors the same everywhere. Thus similar currents are induced in each of the two wires, but being opposite in direction, as far as the circuit is concerned, they neutralise each other, and the circuit, therefore, becomes quite silent.

In England we make the two wires revolve completely round each other in every four poles, but in France it is done in every six poles. The reason for the change is the fact that in the English plan the actual crossing of the wires takes place in the span between the poles, while in the French plan it takes place at the poles. This is supposed to reduce the liability of the wires to be thrown into contact with each other by the wind, but, on the other hand, it diminishes the geometrical symmetry of the wires—so very essential to ensure silence. As a matter of fact, contacts do not occur on well-constructed lines, and I think our English wires, being more symmetrical, are freer from external disturbance than those in France.

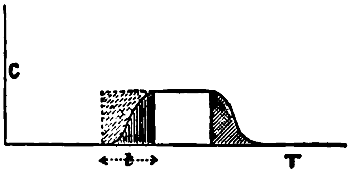

FIG. 1.

(*b*.) The internal opposition arises from the resistance, R, the capacity, K, and the electromagnetic inertia, L, of the circuit. A current of electricity takes time to rise to its maximum strength and time to fall back again to zero. Every circuit has what is called its time constant, *t*, Fig. 1, which regulates the number of current waves which can be transmitted through it per second. This is the time the current takes to rise from zero to its working maximum and the time it takes to fall from this maximum to zero again, shown by the shaded portions of the figure; the duration of the working current being immaterial and shown by the unshaded portion. The most rapid form of quick telegraphy requires about 150 currents per second, currents each of which must rise and fall in $\frac{1}{150}$th of a second, but for ordinary telephone speaking we must have about 1,500 currents per second, or the time which each current rises from zero to its maximum intensity must not exceed $\frac{1}{3000}$th part of a second. The time constant of a telephone circuit should therefore not be less than ·0003 second.

Resistance alone does not affect the time constant. It diminishes the intensity or strength of the currents only; but resistance, combined with electromagnetic inertia and with capacity, has a serious retarding effect on the rate of rise and fall of the currents. They increase the time constant and introduce a slowness which may be called retardance, for they diminish the rate at which currents can be transmitted. Now the retardance due to electromagnetic inertia increases directly with the amount of electromagnetic inertia present, but it diminishes with the amount of resistance of the conductor. It is expressed by the ratio $\frac{L}{R}$ while that due to capacity increases directly, both with the capacity and with the resistance, and it is expressed by the product, K R. The whole retardance, and, therefore, the speed of working the circuit or the clearness of speech, is given by the equation

$$\frac{L}{R} + KR = t$$

or

$$L + KR^2 = Rt.$$

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* Paper read before the British Association.

within one or two in a million. After standing for nearly three weeks they were marked all over, and varied nearly a tenth per cent. among themselves, and more than that compared with 1,621, which had been in another solution acting as a standard in other experiments.

From this it appears that in order to give good results the zincs should be heavily amalgamated. If thoroughly amalgamated, practically any zinc will do. The zincs which gave low E.M.F.'s were always the small ones—that is to say, those which would get the thickest coatings of iron.

To find out whether amalgamating altered the readings, an amalgam was made by touching mercury with zinc. It was more than ½ per cent. wrong. After dissolving more zinc, the reading was still low, though by stirring in zinc it soon came up to 0·9984 and 0·9994. A series of amalgams was made containing 25, 12½, 5, 2½, and 1 per cent. of zinc and one with less zinc. These were put in solution 1,628 of zinc sulphate with little iron. The solution was poured in and out many times to secure homogeneity, an important matter, to which I will return. The readings obtained were—

25 per cent.	1·000025	and	0·99999	
12½	,,	1·00008	,,	1·000000
5	,,	1·000035	,,	1·000010
2½	,,	1·00005	,,	1·000020
1	,,	0·997225		
trace below 0·995				

The second readings, which were taken a few minutes later, are close enough. Amalgams therefore having some 2½ per cent. of zinc will do. Lord Rayleigh has done a great deal of work on amalgam cells, and he found the amalgam always cracked the tube. I made one H cell with amalgam in 1888 which had the platinum led out at the bottom, but it did not crack. I made several other cells at the same time with an internal test tube to hold the amalgam, and none of them cracked. On the other hand, the 5 per cent. amalgam broke its test tube. I would suggest that platinum sealed to German glass is always left under constraint, and the crystallisation of the zinc also adds pressure which cracks the tube. My H cell had a little lead glass just round the platinum; moreover, it was very small. The 2½ per cent. amalgam is liquid, so there is no danger from it.

To sum up as to the zinc, then, I would suggest that if rod be used it should be well amalgamated first. It is gradually amalgamated in the cell, but this process is slow, especially if the solution contains basic zinc sulphate. The gradual amalgamation is probably one process that makes many cells take a few weeks to arrive at final values. If zinc rod is used, it would seem better to use platinum, silver, or zinc wire to make connection, and to avoid solder, otherwise it is only a matter of time till the zinc falls off. All these troubles are swept away by the use of zinc amalgam, as proposed by Lord Rayleigh. There is another reason in its favour to be mentioned under the head of temperature coefficients.

THE ZINC SULPHATE SOLUTION.

The chief difficulty arises from the presence of iron. Samples were bought from Messrs. Hopkin and Williams and Becker. These both contained iron. Iron is often to be seen as a deposit after shaking up with zinc carbonate. Some sulphate of zinc was made by dissolving "pure" zinc in redistilled sulphuric acid. Provided there is always excess of zinc, one would expect little iron. Another batch was made by leaving excess of commercial granulated zinc in dilute commercial acid, which itself contains iron. Neither of these had enough iron to blacken zinc. None of the samples of zinc sulphate blackened copper. When I say that samples of sulphate of zinc bought as pure from such people as Messrs. Hopkin and Williams contain iron, I mean that they contain enough to cause variations in cells, not enough to get precipitates of Prussian blue. Zinc or barium carbonate might be expected to precipitate all the iron. It does not, however. Probably carbonate of iron really exists and remains in solution. In experiments on alkaline secondary cells with iron plates, I produced a green compound which appeared to be a real carbonate of iron. The best method of dealing with iron is to acknowledge its presence and amalgamate the zincs. The best zinc sulphate solutions I used were obtained by dissolving granulated zinc in dilute commercial acid, keeping the zinc in excess. Solution 1,628, already mentioned, was made this way. Of course, pure zinc and acid may be used. This method produces basic sulphate, too, especially if hot. This can be afterwards neutralised by acid.

It is usual to shake up zinc sulphate with "carbonate," and to filter before use. This is probably because the sulphate reddens litmus paper. Neutral zinc sulphate reddens litmus paper, however, so there seems little reason for adding zinc "carbonate." I imagine that any salt which can give up a little acid by forming a basic salt, will redden litmus. The sulphate can be neutralised by being left in contact with zinc. A solution that is strongly alkaline to methyl orange reddens litmus paper. What is bought as zinc "carbonate," is either a basic carbonate or a mixture containing oxide. There are some half-dozen basic sulphates of zinc, and shaking up with "carbonate" forms some of these. The presence of basic sulphate in the solution prevents the mercury salt getting to the zinc to amalgamate it. Mercurous sulphate is, I believe, split up by water into basic and acid mercurous sulphate. Basic zinc sulphate precipitates any normal mercurous sulphate that may be dissolved, and the acid sulphate as basic mercurous sulphate or as mercurous oxide. This accounts for the dark grey deposit often seen on the top of the paste in cells prepared in the usual way. The mercury salt thus cannot get to the zinc till the whole of the basic zinc salt has been used up.

In order to test the effects of various solutions of zinc sulphate, test tubes with feet were filled with the solutions, and were connected with the standard solution by a syphon tube. This had one end blocked with filter paper to prevent mixture of solutions. It is needless to give tables of readings. Anomalous results were obtained at first, but they were all traceable to the zincs. After amalgamation, all the saturated solutions gave the same readings within a few in a million. 1,621, made by dissolving pure zinc in acid, was 100 in a million too low.

To test the effect of acid, I added a few drops of "normal"—that is, very dilute sulphuric acid—to a saturated solution of Hopkin and Williams's zinc sulphate. The solution was then strongly acid to methyl orange. The solution read 1·001200 against zinc, 1,621 in some more of the same solution. On neutralising with zinc carbonate, the reading was 1·001100. Free acid appears to make little difference. This experiment was repeated with new solutions. The two zincs were first tested in the same solution. One gave about eight in a million; this was moved into the other tube, B, of the same solution and taken as a standard. The reading was now 1·000110 for A. Five drops of pure acid were put in a small test tube, and a little of A added, and the tube cooled. Then the acid was added to A, which became strongly acid to methyl orange. The reading was now 1·000000. The liquid was then shaken up with zinc carbonate till alkaline to orange, and the reading rose to 1·0009. On the other hand, a solution which had been left in contact with excess of zinc carbonate for some weeks gave no deflection. In any case, the zinc will eventually use up any free acid. These anomalous results may be partly due to slight differences of density in the solutions, and partly to unascertained causes.

This is the last point that need be mentioned in connection with the solution. The solubility of zinc sulphate varies enormously with the temperature. If a tube of it is left with crystals at the bottom, when it comes to a low temperature all the crystals collect at the foot. When the temperature rises, the upper part can only become saturated again slowly by diffusion. To test this, two zincs were put in a test tube of saturated solution with crystals at the bottom. After a few days the top zinc gave 1·0005 compared with the bottom. The lower zinc was then raised, reading 1. The other zinc was then depressed, reading 0·999475. The difference of density thus causes an error of 5 in 10,000. This tube was some 10 centimetres long, so the error in standard cells may not be so great as this, still, diffusion is very slow even in a short cell. This also influences the temperature coefficient. The question of supersaturation has already been dealt with so thoroughly by Lord Rayleigh that I saw no use in experimenting on it. There are some half-dozen hydrates and an anhydrous sulphate of zinc. If the solution is not heated above blood heat, the $Zn\ SO_4\ 7H_2O$ crystallises out.

To sum up: the chief errors caused by the solution are due to traces of iron and variations of density. The zinc should therefore be amalgamated. I would suggest that zinc carbonate be omitted. To avoid changes of density, if a saturated solution is imperative, a zinc amalgam must be employed with crystals lying on its surface. This can be done in one of Lord Rayleigh's H cells, or a smaller tube can be slipped into the cell. The surfaces must be on the same level, else all the crystals will collect on the lower one, as that lowers the centre of gravity of the system, thus doing work. A small test tube full of crystals was put inside a larger tube of saturated solution, and this action was found actually to take place.

There is some further complication between the zinc and its solution. Even amalgams will give very large variations if moved about in the solution. This is the case even with dilute solutions. I can scarcely hazard a suggestion. Some Lippmann effect may be produced by shaking the amalgam. This does not seem at all likely. It is possible that zinc, even when amalgamated, will dissolve in sulphate, forming basic sulphate, provided the zinc is moved so that the hydrogen can get away in solution, as it cannot come off in bubbles. Ordinary zinc will dissolve in boiling zinc sulphate solution, the solution turning milky on cooling; but I cannot make out whether amalgamated zinc does or not. In the cold it gives off bubbles slowly. I do not know whether any surface boundary layers can cause such effects; whether there is an action like a frictional electric machine going on.

MERCUROUS SULPHATE.

Samples of mercurous sulphate were bought from Messrs. Becker and Hopkin and Williams. I also had some samples from Hopkin and Williams, Becker and Griffin, bought in 1888, and some I made myself at the same time. I also prepared some new specimens by heating in an oven a flask with mercury twice distilled in vacuo and redistilled acid. The temperature was kept at 125deg. C. by a mercury regulator, and only a portion of the mercury was dissolved. The sulphate was washed with distilled water and dried. It is in white crystals.

Other samples were made by dissolving mercurous nitrate in water slightly acidified with nitric acid, and precipitating with zinc sulphate. This is perfectly white unless much washed. A yellow colour then appears.

There are several sulphates of mercury. There is mercuric sulphate, which, on shaking up with water, splits into acid mercuric sulphate, which is soluble, and basic mercuric sulphate, which is a bright yellow insoluble powder. There is, I believe, a mercuric-mercurous sulphalte. I do not know it, nor do I know if there are acid and basic salts to correspond. There is also mercurous sulphate, which some say is soluble in water, but which, I believe, splits up into acid mercurous sulphate, which is slightly soluble, and basic mercurous sulphate, which is a dirty yellow powder. In testing the pastes, some of that used for the

B.O.T. cells was used as a standard. Zinc No. 1,621 was kept in solution of sulphate, and was connected by a syphon with the tube f standard paste, the cell thus made being checked against the B.O.T. standard. After a few days there was never any deflecion. The pastes could not be measured so easily as zincs or olutions on account of their high resistance. There is also requent trouble from want of contact with the platinum wires. Merely heating these and dipping in mercury is not always nough. I found it better to bend the platinum into an eye and o boil it in mercury, and not to consider it amalgamated till it ook up a film of mercury with it, or to use sodium amalgam. The yphon tube was no longer stopped with filter paper, so its resistance was lower. Some of the experiments on pastes are given n the following table:

1,650 was B.O.T. paste. Its readings are given in terms of 1,615, the B.O.T. standard. The other pastes are given in terms of 1,650. Columns one, two, and three are not corrected for the variation of 1,650, as from the readings of 1,653, 1,654, and 1,654, t looks as if the B.O.T. cell had been varying owing to alterations of density of the zinc sulphate solution.

1,651.—Paste given to me by Mr. Fox Bourne. The bottle had Becker's label, but the paste was grey like that of Hopkin and Williams, from whom Mr. Fox Bourne had also bought sulphate. It was always far too high.

1,652.—Paste of basic mercuric sulphate. This was always very low. This goes to show that basic mercuric sulphate is harmless, so that mercuric sulphate may perhaps be rendered harmless by washing it thoroughly.

1,653.—Paste made by dissolving mercury as already described. It began low, gradually coming to be too high on shaking.

1,654.—Paste made by precipitating mercurous nitrate with zinc sulphate. This is quite white unless copiously washed, then it is slightly yellow owing to the presence of basic protosulphate. Tap water containing chalk must not be used for washing. This paste contains no mercuric salts. To test the pastes for mercuric salts, they were shaken with water and the solution precipitated with salt and filtered. The filtrate was tested with hydrogen sulphide and with potassium iodide. This paste seem right.

1,655.—Paste bought in 1891 from Becker. This was a white powder, and remained white as paste. Contained no persalt. Gradually fell to normal. The pastes nearly always give high readings after stirring up well.

1,656.—Paste from Hopkin and Williams, 1891. Powder, grey, turning yellowish in the paste, contains a good deal of persalt. This is the paste generally used for cells. Two other specimens bought from the same firm some years ago also contained persulphate. The paste begins very high, gradually falling. Washing out the persulphate may help this. I do not know if sodium formate could be used to reduce the persalt.

1,657.—Paste from Griffin. Grey powder. Contains a great deal of persalt. On July 24th, 1891, excess of zinc carbonate was added to this paste. It frothed up and remained as a sort of sponge. The reading then fell gradually till it was too low.

1,658.—Paste made by slow electrolysis. M. Potier has proposed a cell made by using a mercury anode and cathode in zinc sulphate; but I have not the reference. The zinc amalgam is, of course, too weak unless a great deal of electricity is passed through. The paste formed is the yellow basic mercurous sulphate. The reading was too high first, and fell to nearly normal. Finally a little acid was added on August 2nd, 1891, and the reading was very high. I made other unsuccessful experiments on Potier cells.

1,612.—H cell with 2½ per cent. amalgam. It was always low, probably because its solution was saturated at both poles. Of course, as this was a complete cell, it was compared direct with the B.O.T. cell, and as the temperature coefficients are different, and as there are other causes of variation, it is impossible to say which was at fault. Readings like those of 1,654 may be got with pastes, but not with different kinds of cell.

1,674.—Becker paste, 1888, with zinc carbonate.

1,675.—Same without carbonate. Probably there was not enough carbonate to convert the whole of the sulphate into basic salt. Lord Rayleigh recommends the addition of a very small quantity of zinc carbonate to the paste. If the paste has persulphate the carbonate will first convert it into basic persulphate, which appears to be harmless. An excess of zinc carbonate will, of course, waste the mercurous sulphate.

1,679.—Complete cell with Becker paste; put in dry.

1,681.—H cell. Becker paste.

1,685.—Paste made by electrolysis in acid solution.

1,688.—Tube cell, with precipitated mercurous sulphate, made in 1888.

It will be seen that the cells seem to tend towards a common value, but that is almost all that can be said.

The Board of Trade circular directs the paste to be rubbed up with mercury. This would tend to reduce the persulphate to protosulphate. Mercury cannot be rubbed up with protosulphate, as it does not oxidise the surface, so the mercury is not "killed," and collects in a globule. The mere fact of the mercury mixing shows that the sulphate is bad.

MERCURY.

To test the effect of impurities, some amalgam containing silver, copper, and zinc was taken. Sodium amalgam was added, and the whole shaken up with salts of lead, iron, antimony, platinum, and tin. The amalgam was then shaken up well with persalts of mercury. The mecuries to be tested were put in little crucibles in a solution of mercurous nitrate. After a few minutes they all agreed.

TEMPERATURE COEFFICIENTS.

The temperature coefficient of several cells was taken with some care. Three cells were tested first. They were put in a bath at about 30deg. C., the temperature being taken at each reading, and the water slightly stirred.

1,682	....	0·000312	and	0·000340
1,684	....	0·000861	,,	0·000840
1,683	....	0·000297	,,	0·000308

The reason for the discrepancy between the first and second reading of each cell is clear; the cell was colder than the water at first, then, as the cell warmed and the water cooled, the cell was left a little hotter than the water in which the thermometer was placed. Some days later the following readings were taken. In this case I kept the temperatures nearly constant by adding hot water.

1,680	....	0·000287	1,685	....	0·000492
1,682	....	0·000421	1,688	....	0·00085
1,683	....	0·000324	1,689	... .	0·00042
1,684	....	0·000756			

Of these cells, 1,680, 1,683, 1,689, had dilute solutions, made up of equal weights of water and $ZnSO_4 \cdot 7H_2O$. 1,680 and 1,683 differed only in the mercury paste; 1,683 gave different coefficients on the two days. The variations in the other cells may be easily explained. If a cell with the zinc at the top has its solution saturated at, say, 15deg. C., and is then heated, the solution round the zinc is no longer saturated. The temperature coefficient of the cell depends on its past history in fact, and is lower in spring than in autumn. An H cell, or a tube cell, with crystals of zinc sulphate in contact with the zinc always has its solution saturated at both platas. 1,682 is an ordinary cell, but the zinc is at the top, hence its low temperature coefficient when heated. If left at 30deg. C. for a few weeks and then cooled, no doubt its temperature coefficient would rise to 0·0008 or 80. 1,684 is an H cell with crystals in both legs 1,685 is an electrolysis cell, with zinc at top. 1,688 is a tube cell, with crystals in both tubes, hence its high coefficient. It is thus clear that the temperature coefficient of a cell may vary from day to day according to its treatment, and may, perhaps, vary 100 per cent. between winter and summer. Even a variation between ·0008 and ·0006 means an error that may in extreme cases amount to something like a half per cent.—that is, it may be outside the limits I have here taken as worth considering. My water bath differed some two or three degrees from one evening to another, and, no doubt, varied more during the day and night. A new cell would thus be saturated at, say, 20deg., while the standard was saturated at, say, 15deg. If the coefficient of one was 0·0008, and of the other 0 0004, the error might easily be 0·0012 due to that alone. To avoid this difficulty the solution must be kept saturated by using the H or tube cell. Some authorities push the zinc into the paste. This may give the same result, but the zinc then amalgamates too much. Sometimes it has beads of mercury hanging to it, and if these are the only surfaces exposed the E.M.F. may be too low. Over-amalgamation also often detaches the zinc by weakening the solder. Moreover, the formation of so much zinc sulphate may use up all the water, thus rendering the cell dry, or producing a less hydrated salt.

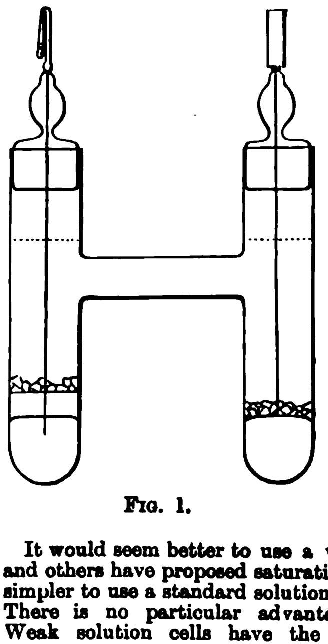

FIG. 1.

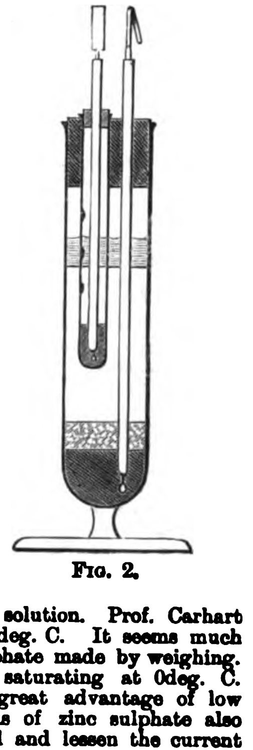

FIG. 2.

It would seem better to use a weaker solution. Prof. Carhart and others have proposed saturating at 0deg. C. It seems much simpler to use a standard solution of sulphate made by weighing. There is no particular advantage in saturating at 0deg. C. Weak solution cells have the very great advantage of low internal resistance. No doubt, crystals of zinc sulphate also lessen the available surfaces of the metal and lessen the current that can be taken without polarisation. The construction of the H cell is shown in Fig. 1. One leg contains amalgam with crystals on it, and the other paste. Platinum wires are sealed through glass stoppers, and end in little bracelet snaps. The stoppers are smeared with vaseline to prevent creeping. Fig. 2

of the propelling-current conductor. If the consignee is connected by telephone or electric bell, the departure of a load for him is duly signalled, and as soon as the down line is sufficiently clear of previously-despatched trains, as indicated by the semaphores, the operator admits current to the insulated section of the conductor, and the train enters the tube. The switch of the siding it is intended for being set, the trains turns into it and signals the fact to the central by breaking contact at T, Diagram 6. The operator thereupon takes off the current, and the switch resumes its normal position. The train runs into the subscriber's premises, where it is gradually brought up, and where it announces its arrival by ringing bells, or otherwise. The load is taken off, the train transferred to the up track, and when it is desired to return it to the central, either with a new lading, or empty, it is placed at the entrance of the tube with the collector against the insulated section of the up propelling-current conductor. The operator is advised by signal that a train is ready for despatch. When he has a clear line he works the electromagnet, which removes the mechanical obstruction, and at the same time gives the motor current, and the train runs up to the central, where its motion is gradually arrested. If the load is consigned to the central, the operator turns the truck or train into the siding assigned for such traffic; if addressed to another subscriber, he transfers it to the down track of his own tube, if the consignee's siding is served by it; if not, he forwards it by means of his turntable to the operator who works the tube it is destined for. So, when one subscriber sends a parcel to another, he despatches it, in the first instance, to the central station, where the operator re-forwards it as required.

Should a truck by mistake be delivered to the wrong siding, the subscriber has only to transfer it to the up track and return it to the central.

Although each subscriber could advantageously be connected, telephonically or telegraphically, with the central, such a means of communication is by no means necessary. Trains, as already stated, would announce their own arrival in the subscribers' premises, and if subscribers would place trains on the up line ready for departure, the operator could withdraw them when convenient without troubling the subscribers further. It would be easy to make a rule for the operators to tap all or particular sidings at prescribed intervals during the day, and so withdraw unannounced traffic. The subscribers could be supplied with empties during the night or slack hours of the day without any attendance on their part. Automatic working could be carried further still, for it would not be difficult to arrange to unload trucks sent into subscriber's buildings, and afterwards withdraw them as empties, without any personal attention. The loads could be tilted off, and the truck, when clear of the down-propelling current, run down an incline and through cross-over points to the up track, where it would find the up-propelling current, and immediately commence its return journey to the central. Thus, a man's coal cellar might be filled in the night by a succession of such automatic trucks.

If desired, the starting levers at the central could be interlocked with the levers controlling the siding switches, so that a following train could not leave until the switch set for the preceding one had been restored to its normal position. Collisions between following trains could be prevented by an automatic block, such as was devised by Jenkin and Elliott and Ayrton and Perry for telpherways, by which the second train loses its propelling current if it approaches the preceding one too closely. These precautions would, however, tend to restrict the capacity for traffic, and, as collisions would not endanger life, I am inclined to think that strongly-built trucks, with good elastic buffers, and perhaps extra deep flanges to the wheels to prevent disrailing, would constitute sufficient safeguards against damage to goods arising from an occasional collision. The operators would not allow two trains on the same section simultaneously, and if the sections are 100 yards in length, I contemplate the possibility of a pair of skilful operators, one for the down, the other for the up track, keeping 34 trains circulating in a tube a mile in length—17 down and 17 up. The various control movements are but momentary, and they would only have to be timed in accordance with the indications of the semaphores. At eight miles an hour, 17 sections to the mile would give nearly half a minute between each train.

The body of the tube, if of metal, could constitute the return for the propelling current. For signalling the progress of trains, one rail of each track might form the outgoing conductor, while the returns could consist of small wires—No. 18 gauge would be ample—made up into cables. One outgoing conductor of No. 12 gauge could carry all the current for operating the siding switches and block electromagnets, the returns being No. 18's cabled. The number of conductors would dwindle as the distance from the central increased, and as they would be small and cheap, the outlay for them would not be considerable. Of course, the various switches and semaphores might also be worked off the parallel conductor supplying the motors, as shown in Diagram 3.

For inspection and repairs a special form of truck or platform, on which a man could crouch or lie, would be provided. The motors of these whould be under the control of the men using them, and they would be fitted with brakes, incandescent lamps, and telephones for communicating with the central.

Although the proposal for a system of this nature may appear a little startling, its details, as I have sketched them, comprise no device that has not been thoroughly tested in the telegraph and signalling departments of the Post Office and railway companies, or in connection with electric traction. Mr. Preece, many years ago, employed electromagnetic semaphores such as I propose. The shifting of switches and blocking by electromagnets has been rendered familiar by the labours of Spagnoletti, while the picking up of current has often been demonstrated, notably on the City and Southwark Electric Railway. It may, consequently, be confidently asserted that the plan would work, and work well.

Whether such a system would pay is another matter. If constructed specially and solely for parcel work, probably it would not, although the surprising developments of the last decade scarcely justify us in assigning limits to the possible developments of the next; but I assume that the construction of subways beneath all the chief thoroughfares of large towns, for the purpose of containing electric light and power leads; telephone wires; pipes for gas; water, fresh and salt; hydraulic and pneumatic tubes; and, perhaps, oxygen or ozone to supply our homes with mountain air, together with other possible adjuncts of our complex civilisation, will shortly become an absolute necessity. A beginning in that direction has already been made by limited companies in some of the American towns, and we must sooner or later follow suit. Then, when that time arrives, an electrical parcel exchange could be carried out economically and effectively as part of the scheme. I look forward to a time when our footpaths and carriageways will be laid upon the lids of huge boxes, through which, perhaps, in addition to the various fittings already named, will be carried well-lighted footways, affording crossings and short cuts for passengers at congested spots.

Supposing, for the sake of argument, that the scheme is financially practicable, its many uses will, I think, be readily admitted. What an aid it would be, for instance, to the postal service were St. Martin's-le-Grand connected by such tubes with the principal post offices in the City and West-end. The telegraphic department at present derives great assistance from pneumatic tubes, an inch or so in diameter, through which crumpled-up telegrams are forced in indiarubber balls. If letter and parcels could be interchanged in a similar manner, deliveries could be both expedited and multiplied, and the capacity of the department generally increased. Parcel-post hampers could be despatched to, and received from, the great railway stations in a minute or two, and the mails of subscribers to the exchange system could be delivered without the aid of postmen, while such subscribers would be able to despatch letters and parcels, together with telegrams and the money to pay the charges thereon, straight to the chief post office, so saving labour and delay at the branches. Such a system would form the first step towards telegraphing, or rather wiring, matter.

Apart from the post office, many uses suggest themselves. Parcel receiving offices and great despatchers of small packages, like the Co-operative Stores, Whiteley, and others, would find direct connection to the railway stations, and with other business houses, an important boon. Buyers could telephone for samples and patterns of all kinds and obtain them almost immediately. Hotels and restaurants could telephone for, and receive, in a few minutes supplies they may run short of, and enable their customers to choose wine, not only from the cellars of the establishment, but from those of every wine merchant on the system. Cooks at private houses could not only telephone for a leg of mutton, but have it ringing a bell in the course of a minute or two to announce its arrival. The story of the doctor prescribing by telephone for a baby whose cough he had listened to by the same means is well known. A friend of mine suggests that, with the parcel exchange system, the mother could improve on that by sending the baby bodily to the doctor, *via* the central station, and receiving it back with a bottle of medicine in its fist and a mustard-leaf on its chest.

DISCUSSION.

Sir Frederick Bramwell said the author had very well thought out the difficulties attendant on such a system as was proposed, and, so far as he could see, he had overcome them all. The only question was, would it pay? He had had some experience in tunnelling, and he believed the tube or tunnel could not be made for less than £13 to £20 per lineal yard. For his own part, he should be very glad if such a scheme could be brought into operation.

Mr. Binnie said this tunnel would take up at least 4ft. by 2ft. under the roadway, and, therefore, in order to introduce this system it would be necessary to shift the whole of the existing mains. The difficulty of making the house connections would also be very great, and he did not see how the work would ever pay as a commercial undertaking. The idea might be worked between the central and branch stations in London, and he had no doubt the Post Office authorities would introduce such a system before long.

Prof. A. C. Elliott thought the only obstacle was that of cost. When the electric light was first introduced, people said it would not be successful because of the cost. In spite of this, however, it had come into fairly general use, and if there was found to be a real necessity for an electric parcels exchange, the difficulty of cost would likewise be overcome.

Mr. Greathead, while admitting the advantages which would be derived from such a system, thought the time was somewhat distant when they could have a complete system of subways such as would be required to bring the scheme into operation.

Mr. Bennett said he had considered this question of subways, and he found that it would be necessary to make a clean sweep of the existing mains and begin over again. The Post Office would soon have to adopt some such system to meet their requirements, and they must be the authorities to initiate the scheme. The parcels post was growing, and a small army of men and mail carts were employed in the transmission of the parcels.

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THE GROWTH OF ELECTRIC LIGHTING.

Quite recently the *Times* had an excellent article to show that the progress of electric lighting in England, and especially in London, was very favourable, even when compared with the progress in the States. One point in the *Times* article seems to have struck some persons as hardly correct. The slow progress after 1882 has usually been attributed to Chamberlain's Act of that year. The *Times* says not so, but to the fact that electrical knowledge was not sufficiently advanced to give what was required. Mr. Massey rather supported the contention of the *Times*, while Mr. Crompton, in a long communication in the issue of last Saturday, waxes somewhat indignant that anyone can imagine the fault to be anywhere but in the Act of Parliament. After all, any discussion upon the point can be of no earthly value. Opinions differ, and many people incline to the view that much may be said for both sides, and that each is partly right and partly wrong. So far as electric lighting is concerned comparisons are odious, and comparison with American progress especially is not worth the paper it is written upon. The conditions existing in the two countries were and are so diametrically different that there might be plenty of incentives to install one artificial light in one place, while there exists quite as strong an incentive to install a different artificial light in another. A town that has no artificial light, or where gas is from 10s. to 20s. per thousand, does not look upon electricity in the same way as when gas is fully installed and costs 2s. 6d. or 3s. 6d. per thousand. It is of little use either to flog a dead horse or to flog a willing horse, and it is of just as little use to attempt to prove that a town in England ought to follow the lead of a town in America, without stating exactly the conditions prevailing at both places.

There is one phase in the history of electric lighting that is never, so far as we know, sufficiently acknowledged by speakers and writers. We have more than once had occasion to ridicule the claims Americans have made for Edison as an inventor, but we are prepared to admit—nay, claim—for Edison, above all men, the position of having first shown that electric lighting on a large scale was practical, and worthy of commercial enterprise. While Englishmen were pottering about—some with this detail and some with that, none, however, troubling about lighting as a whole—Edison was busy working out a complete system, giving due attention to motors, dynamos, mains, and lamps, endeavouring to make every part fit and work smoothly as a whole. It matters not that the dynamos of that time, as compared with the dynamos of the present day, partook somewhat of the nature of leviathans; the New York installation from a central station was a practical success.

A consideration of the work that Edison did in America will go far to prove Mr. Crompton's contention, at any rate, to be partially correct. He exists, while the price is above the means of the many. In some European towns the telephone enters largely into public use. In a small place like Christiania, for instance, the whole business of the place is done on the telephone, as also is the case in Stockholm. A report from the Consular service, dated 1890, gives a very full account of the use of the telephone in Norway and Sweden. The price does not exceed £4 to £4. 10s. per year to subscribers. In a town like London we might fairly expect that one in 50 at least would be subscribers among offices, shops, and residents.

One insuperable difficulty, however, has existed besides the large cost of £20 a year which the National Company have been charging to subscribers—viz., that the system has been a single-wire system of overhead wires carried on poles above houses, and the return current between subscribers has been taken by the earth. The consequence has been that the telephone has tried the patience of everybody from its inaudibility, while the primitive system of exchanges and the fewness of these exchanges have made the delays in "getting through," as it is called, on the telephone simply intolerable. Every one who has got a telephone in his house to-day is in open revolt against the instrument, on account of its irritating bell and its subsequent failure to make itself efficient as a means of conversation. Now all this is changed when we come to the Paris and London telephone. I have heard the tick of the watch of the person I was speaking to in the Rue de Grenelle from the London General Post Office, and I could have conversed for hours as if I had been in the same room with my correspondent. This telephone is a complete metallic circuit with no earth return. The same result is arrived at wherever the twin wire is used, and Mr. Bennett's plan was interesting in showing that it is easy, at a very moderate cost, to telephone the whole of London on the twin-wire system, and, with the new system of exchange appliances, to do away with all the delays in getting through from one person to another. Moreover, it is demonstrable that this can be accomplished at a remunerative profit for a £10 a year subscription for the whole of the London district of five millions of inhabitants. It is much to be feared that the National Company will never be able to reduce their rate to a £10 level, as all the money they paid for patents should be written off this year, their last important patents having expired. Further, their system being entirely single-wire, with overhead connections, and with no general scheme for dividing London up into central exchanges, it would be necessary for them to relay the whole of their wires and exchanges from end to end before they could extend their system or improve their service to any practical extent.

Another matter of vital importance is to be able to get all main trunk wires underground, and not only free the air from these black monstrosities, but also be able to establish sufficient lines between central and sub-stations. In order to obtain this object, it is necessary to go to Parliament for powers for laying their wires underground. This is about to be done, and a new company, which possesses a license from the Postmaster-General, is about to promote a Bill before Parliament next session with the object of establishing a complete twin-wire telephone service for the whole of London on the basis of a £10 a year rental, and with a system based on the plan worked out by Mr. Bennett, so that the telephone will be available to everybody for their business, their shopping, and their social needs. The scheme is a most interesting one, and, with the possibility of getting all the trunk lines underground, the darkening of the air by large cables will be completely obviated and done away with. We may, therefore, hope before long to realise the plans set forth at the British Association meeting, and be able from our own writing-tables to speak with a friend in his country home, or even discourse with a friend in Paris as to his doings, and also convey our social invitations about town without having to write interminable notes and make numberless cab journeys, often to no avail.

THE BRITISH ASSOCIATION AT CARDIFF.

PRESIDENTIAL ADDRESS BY WILLIAM HUGGINS, Esq.

(*Continued from page 209.*)

Now this state of things, in which the masses, though not equal, are of the same order, does seem to prevail in many nebulæ, and to have given birth to a large class of binary stars. Mr. See has recently investigated the evolution of bodies of this class, and points out that their radical differences from the solar system in the relatively large mass-ratios of the component bodies, as well as in the high eccentricities of the orbits brought about by tidal friction, which would play a more important part in the evolution of such systems. Considering the large number of these bodies, he suggests that the solar system should perhaps no longer be regarded as representing celestial evolution in its normal form—

> "A goodly Paterne to whose perfect mould
> He fashioned them . . ."

but rather as modified by conditions which are exceptional,

It may be well that in the very early stages condensing masses are subject to very different conditions, and that condensation may not always begin at one or two centres, but sometimes set in at a large number of points, and proceed in the different cases along very different lines of evolution.

Besides its more direct use in the chemical analysis of the heavenly bodies, the spectroscope has given to us a great and unexpected power of advance along the lines of the older astronomy. In the future a higher value may, indeed, be placed upon this indirect use of the spectroscope than upon its chemical revelations.

By no direct astronomical methods could motions of approach or of recession of the stars be even detected, much less could they be measured. A body coming directly towards us or going directly from us appears to stand still. In the case of the stars we can receive no assistance from change of size or of brightness. The stars show no true discs in our instruments, and the nearest of them is so far off that if it were approaching us at the rate of a hundred miles in a second of time a whole century of such rapid approach would not do more than increase its brightness by the one-fortieth part.

Still, it was only too clear that so long as we were unable to ascertain directly those components of the stars' motions which lie in the line of sight, the speed and direction of the solar motion in space, and many of the great problems of the constitution of the heavens, must remain more or less imperfectly known. Now the spectroscope has placed in our hands this power, which, though so essential, appeared almost in the nature of things to lie for ever beyond our grasp. It enables us to measure directly, and under favourable circumstances, to within a mile per second, or even less, the speed of approach or of recession of a heavenly body. This method of observation has the great advantage for the astronomer of being independent of the distance of the moving body, and is therefore as applicable and as certain in the case of a body on the extreme confines of the visible universe, so long as it is bright enough, as in the case of a neighbouring planet.

Doppler had suggested as far back as 1841 that the same principle, on which he had shown that a sound should become sharper or flatter if there were an approach or a recession between the ear and the source of the sound, would apply equally to light; and he went on to say that the difference of colour of some of the binary stars might be produced in this way by their motions. Doppler was right in that the principle is true in the case of light, but he was wrong in the particular conclusion which he drew from it. Even if we suppose a star to be moving with a sufficiently enormous velocity to alter sensibly its colour to the eye, no such change would actually be seen, for the reason that the store of invisible light beyond both limits of the visible spectrum, the blue and the red, would be drawn upon, and light-waves invisible to us would be exalted or degraded so as to take the place of those raised or lowered in the visible region, and the colour of the star would remain unchanged. About eight years later Fizeau pointed out the importance of considering the individual wave-lengths of which white light is composed. As soon, however, as we had learned to recognise the lines of known substances in the spectra of the heavenly bodies, Doppler's principle became applicable as the basis of a new and most fruitful method of investigation. The measurement of the small shift of the celestial lines from their true positions, as shown by the same lines in the spectrum of a terrestial substance, gives to us the means of ascertaining directly in miles per second the speed of approach or of recession of the heavenly body from which the light has come.

An account of the first application of this method of research to the stars, which was made in my observatory in 1868, was given by Sir Gabriel Stokes from this chair at the meeting at Exeter in 1869. The stellar motions determined by me were shortly after confirmed by Prof. Vogel in the case of Sirius, and in case of other stars by Mr. Christie, now Astronomer Royal, at Greenwich; but necessarily in consequence of the inadequacy of the instruments then in use for so delicate an enquiry, the amounts of these motions were but approximate.

The method was shortly afterwards taken up systemmatically at Greenwich and at the Rugby Observatory. It is to be greatly regretted that for some reasons the results have not been sufficiently accordant and accurate for a research of such exceptional delicacy. On this account, probably, as well as that the spectroscope at that early time had scarcely become a familiar instrument in the observatory, astronomers were slow in availing themselves of this new and remarkable power of investigation. That this comparative neglect of so truly wonderful a method of ascertaining what was otherwise outside our powers of observation has greatly retarded the progress of astronomy during the last 15 years, is but too clearly shown by the brilliant results which within the last couple of years have followed fast upon the recent masterly application of this method by photography at Potsdam, and by eye with the needful accuracy at the Lick Observatory. At last this use of the spectroscope has taken its true place as one of the most potent methods of astronomical research. It gives us the motions of approach and of recession, not in angular measures, which depend for their translation into actual velocities upon separate determinations of parallactic displacements, but once in terrestrial units of distance.

This method of work will doubtless be very prominent in the astronomy of the near future, and to it probably we shall have to look for the more important discoveries in sidereal astronomy which will be made during the coming century.

In his recent application of photography to this method of determining celestial motions, Prof. Vogel, assisted by Dr. Scheiner, considering the importance of obtaining the spectrum of as many stars as possible on an extended scale without an exposure thus flows from the auxiliary batteries to the auxiliary lamps. When the train is once more coupled up, the connection is broken at the piece J, Fig. 4, and the main lighting leads then come into action, and the auxiliary lamps go out.

The smaller diagram, Fig. 2, represents the working of the same systems by the use of two through leads instead of four. This we consider equally efficient and more economical.

The main lighting current from main + B passes round coil C, and, when switch D is closed, lights the large lamps or filaments, and in passing round C, it actuates armature, E, raising it and making contact, F, and holding it there during the whole time main lamps are lit. The auxiliary battery, G, is thus placed in communication with main + by means of the switch H, which, when closed, charges the auxiliary battery through the resistance, J.

When the main lighting circuit is broken in any way, the current in C is also broken, and the armature, F, falls and makes contact, K, and the auxiliary switch, L, being closed the auxiliary lamps light up. When the main lamps are once more lit the auxiliary lamps are automatically put out by the action of E.

In the double-filament lamps, Fig. 3, the large + is connected to piece A, the small + to piece B, while the brass casing, C, forms the common negative to both filaments, and this casing makes contact with the lampholder which is attached to the general negative main.

Fig. 4 shows cross-section of the coupler for the four-wire system ; Fig. 5 the longitudinal section ; and Fig. 6 the sectional plan. The five strips correspond, and are attached to the five leads, A, B, C, D, E, respectively, shown on main diagram, Fig. 1.

The strips are all pivoted on the pin F, and are all insulated from it and from each other by the insulation shown in black. The pin G carries upon it the insulating piece, H, upon which the three strips A, B, C rest when the couplers are detached, and it also carries the brass piece, J, which is itself insulated from the pin G. The object of the piece, J, is to automatically connect the two strips D and E when the couplers are separated, and thus light up the auxiliary lamps, as shown on diagram of general arrangement. The pin, K, entering the hole, L, of the corresponding coupler, ensures the accurate meeting of the various strips and prevents short-circuiting. As the couplers are pressed together, the curved ends of the strips engage with each other and hold the couplers together. The springs, M, keep the strips in connection with their corresponding strips, or with the piece J when advisable. If the two-wire system is used, only two strips are necessary.

In conclusion, we would remark that we can only claim as absolutely new in principle (as apart from the details of couplers and double-filament lamps and other mechanical matters) the combination of a main lighting circuit with high E.M.F. and efficient economy, together with an auxiliary lighting circuit and lamps with small batteries and economy in weight, cost, and maintenance.

DISCUSSION.

Mr. Killingworth Hedges thought that the subject of train lighting was one of great importance. It was to be regretted that Mr. Timmis's paper did not come on earlier in the day, when more attention could have been given to it. With the main conditions laid down by Mr. Timmis, particularly the one which stated that every carriage ought to carry its own store of electricity, he cordially agreed ; in fact, he had advocated the same plan three years ago at the British Association meeting at Manchester. He must say, however, that it had been rather difficult to convince the railway authorities that they must, in order to break up their trains, put a battery in each carriage. It appeared to him that the main circuit and the auxiliary circuit when connected must be a very complicated system, and, indeed, one that would be difficult to arrange unless rolling-stock were joined together. He could not see the good of the auxiliary circuit, because if they lighted with batteries connected up in a carriage, why not put in batteries of small capacity, perhaps, three or four hours' storage, and work them from the dynamo, which in ordinary times when the train is in motion lights the whole installation. The auxiliary limits of lower candle-power would offer grave objections, because people would sooner do without the electric light than have it suddenly lowered. In his (the speaker's) paper at Manchester, he mentioned batteries having zinc and lead electrodes. Since then little had been done with them, but the other day, when seeing Mr. Webb, of the North-Western, he was told that they were acting extremely well, experimentally. If such cells were used they might obviate the difficulty complained of by Mr. Timmis in ordinary secondary batteries. At any rate, he thought it would be quite practicable to put a set of batteries either of zinc and lead or the ordinary batteries in a carriage, and get sufficient capacity to attempt all the lighting during ordinary stoppages at stations. One great objection to heavy batteries was the liability to be broken. When travelling on the Midland the other day, where a good system of electric light was used, he found the electric light was not at work. Upon asking the reason, he found that the train at one of the stations ran into the station buffers with sufficient force to knock the batteries out of the case and break it, and the orders were, that until it was put together again, not to use the dynamo. On the Midland they had tried successfully a very important experiment, and that was one advocated at the British Association by Mr. Preece ; it was known as Mr. Barber-Starkey's plan, and consisted of filling up cells with plaster of Paris and making them quite solid, and he was told that it acted admirably. In conclusion, the speaker expressed confidence in the fact that electricity must very soon be the illuminant used for trains, and pointed out the disastrous consequences of a collision between trains lighted by gas.

Mr. Bennett referred to a system of lighting used on the North British Railway.

Mr. Smith, in replying for Mr. Timmis, said, in reference to Mr. Hedges's objection to heavy batteries, it was that very reason which impelled Mr. Timmis to put small batteries in each carriage. Mr. Hedges did not quite see that was that system—no dynamo was used. If there was a large battery, then there was no small one. It amounted to this, that if they had a charging station where they lighted the railway station, one used the same plant to charge the big battery in the guard's van. If the big battery was employed to light the main lights, then only little batteries were required to light the auxiliary lights. These could be left in the carriages from one month to another, with only occasional supervision, because they were charged from the big battery. As to the diminution of light it was not so serious as Mr. Hedges supposed. The reduction was from 16 c.p. to 10 c.p., which was quite good enough to read by. This, however, only occurred in stations, and it was supposed that the diminution of light here would not be very noticeable—at least, it would form no serious inconvenience.

ON THE ELECTRIFICATION OF STEEL NEEDLE-POINTS IN AIR.*

BY A. P. CHATTOCK.

(Concluded from page 203.)

Although the silent discharge from a point does not appear to have the power of permanently clearing away surface-resistance, sparks do so readily enough—though under suitable circumstances they will also form it again. In making the measurements on needle B (Table I.), the discharge at the last recorded (+) reading took the form of a spark. $\sqrt{P}$ was here 1·59. On repeating the reading it had risen to 1·95. A third discharge brought it back to 1·62, and after that it continued to oscillate between these two values for some 20 or 30 times with hardly a break in the regularity. Obviously one spark formed a resistance and the next blew it away again. The character of the sparks was quite different, too. The one which formed the resistance was thin and sharply defined, and spread out for a considerable distance over the plate like a splash. The other was much brighter, straight, and without any signs of a defined edge.

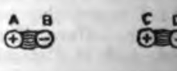
While, however, the above is evidence of the existence of surface-resistance at used points, the fact that the values of f at beginning and end of discharge are practically identical for a clean point for both positive and negative electricity, may be regarded as showing that such resistance is either very small or non-existent on points which have not been used before.

Atomic Charge

§ 6. Assuming, then, provisionally that cohesion in Grotthuss chains is the sole cause of the resistance offered to discharge at a clean point, and that gas atoms are consequently concerned in carrying the electricity when it does so,† there arises the interesting question as to the amount of charge carried by each atom ; and one is tempted to see whether the above measurements throw any light on it. Without in any way pretending to settle the point, the following considerations seem to me to render it probable that the electro-chemical equivalent of gas atoms is of the same order of magnitude as that of the same atoms in electrolytes.

The essence of a Grotthuss chain is that it shall consist of molecules capable of being split into two parts, one of which is charged after the split with positive electricity and the other with negative. These charges may exist separately in the molecules to start with, or they may be induced by an electrostatic field—but in either case it is the field which subsequently arranges them in chains ; and the breaking down of the chains occurs when the mechanical pull of the field on the charged parts is sufficient to overcome their mutual affinity. This affinity may be due to one of two causes or their combinations. Either it is (a) the electrical attraction of two initial charges, or it is (b) a cohesive attraction without any previously existing charges, or it is (c) both. One of these three it must be, if by cohesive attraction is understood the sum of all non-electrical forces betwe [illegible] parts of the molecule.

Consider the first (a) of these cas [illegible] ules hold together by internal charges, they [illegible] thus in their free state :



the lines in between the pairs of [illegible] static force. A chain of such [illegible] put in a field of force just [illegible] charges by induction, so that [illegible] and B, C and D, etc., as befo [illegible]

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* Paper read before the B [illegible]

† This does not preclude [illegible] discharge after it has once [illegible]

A pretty illustration of the influence of point curvature on *n* was accidentally met with in the case of needle C. In getting it into the apparatus for repetition of the curves obtained with it, its point came against the metal box, and was flattened slightly to a width of about $3{\cdot}6 \times 10^{-3}$ centimetres. Tho values of n_1 and n_2 obtained from it after this were respectively 0·42 and 0·30, instead of 0·31 and 0·2 for the finer point.

Grotthuss chains, coupled with constant atomic charge, are thus well able to explain most of the phenomena described in this paper. There still remains one which is perhaps the most important of all—the difference in the behaviour of positive and negative discharge. This I hope to discuss in connection with experiments now in progress, but it may perhaps be well to place on record the results so far obtained.

TABLE IV.

	r.		*k.*
C	$0{\cdot}7 \times 10^{3}$		1·36
D	1·6	,,	1·42
F	4·03	,,	1·40
G	4·84	,,	1·26
H	6·52	,,	1·28
I	7·11	,,	1·23
J	7·83	,,	1·24
K	8·71	,,	1·32
L	10·9	,,	1·13
M	31·8	,,	1·08
N	45·7	,,	0·94
O	58·0	,,	0·94
X	400·0	,,	0·83

These are given in Table IV., where *k* is the ratio at a pressure of 20 centimetres of *f* for positive discharge to *f* for the negative. The ratio shows a distinct tendency to decrease as *r* increases. It is almost useless to give values at higher pressures on account of the uncertainty as to the condition of the point, and the great effect this may have on the negative discharge (Curves III.); but the ratio is distinctly less at higher pressures, for points which seemed quite clean; the decrease of *k* at 70 centimetres mercury varying from 3 to 8 per cent. as compared with *k* at 20 centimetres. For dirty points the decrease may reach 50 per cent.

Description of Apparatus.

§ 8. The electrometer used for potential measurements was constructed on the principle of the one designed some years ago for absolute measurement of much smaller quantities by Prof. Minchin. The attracted disc is suspended, and the force of attraction measured by tilting the whole instrument until the disc falls back by its weight to a fixed point. The disc is a sheet of mica, covered on one side with tinfoil and metallically connected with the case of the instrument, which is a tin cylindrical box 30 centimetres long by 30 centimetres diameter. The disc hangs just outside a 3in. hole in a tin screen at one end of the case, and opposite the hole inside the case is an adjustable disc of tin which forms the attracting plate. The sensitiveness of the instrument may be varied very greatly by altering the distance between this plate and the suspended disc. This arrangement does not of course permit of absolute measurement, but it was thought that calibration in terms of spark-lengths was sufficiently accurate for the work in hand.

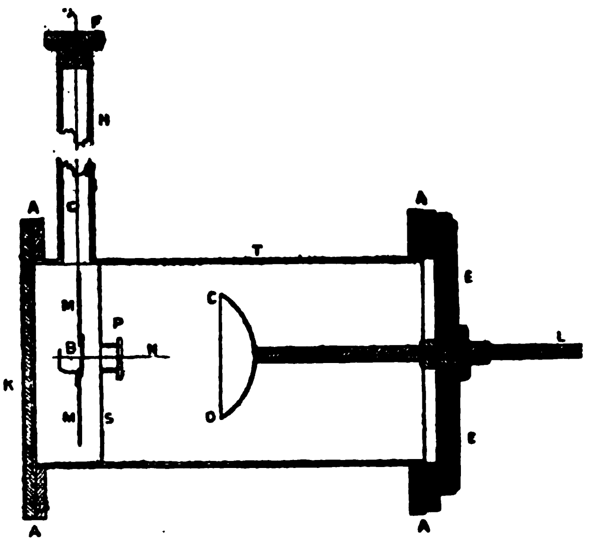


FIG. 1.—T, brass tube forming body of instrument; length 10 centimetres, diameter 6 centimetres.
H, tube for suspension wire, G. F, ebonite plug.
M, mica disc suspended from G, carrying light metal clip B, holding needle N.
S, tin screen soldered into T.
K, metal cover. E, ebonite cover.
A A, ground air-tight joints, greased.
C D, spherical metal cup to be electrified; C D = 3·35 centimetre, radius of curvature = 1·76 centimetre.
P, short brass tube on S; length = 0·5 centimetre, diameter = 1·2 centimetre.
Point of N at centre of curvature of C D. Length of needle projecting beyond P = 2 centimetres.

The same principle of tilting was used in measuring the attractions on the needle-points; the needle in this case taking the place of the suspended disc. The zero position was determined by a hair in the eye-piece of a microscope through which the point of the needle was observed; the latter being at the centre of curvature of C D, Fig. 1, when it coincided with the hair. The needle was illuminated by small windows in T (not shown). L was connected to the Wimshurst; T to earth; and G—*i.e.*, N—through a high-resistance galvanometer to earth, the indications of the galvanometer being therefore due only to current discharged from N. A much larger instrument, constructed on the same lines, was used for needle A and other measurements. The body of this instrument is a tin cylinder, 43 centimetres long (horizontally) and 23 centimetres in diameter. The needle is suspended in a small metal box at the centre, and the electrified plate is supported like C D, Fig. 1, from one end.

The tilting is effected in each of the above instruments by fixing them to a brass base, provided with pivots at one end and a vertical micrometer-screw with large divided head at the other. The method works admirably.

In conclusion, I wish to express my thanks to my friend Mr. F. B. Fawcett, a former student of University College, Bristol, and to my assistant Mr. J. Quick, for much careful help in carrying out the measurements described in this paper. To Prof. Lodge my thanks are so numerous that I cannot express them. His kindness, both by word and by deed, has been unceasing. Indeed but for him this paper would probably never have been written.

Results.

1. Point-discharge depends only on the strength of field close to the point between pressures of 76 and 10 centimetres.
2. Field here measured absolutely by its pull on the point.
3. Seat of resistance to discharge shown to be in gas only, for a clean point (Grotthuss chain).
4. Atomic charge, probably of same order of magnitude as ionic charge.
5. Effects of pressure and of point-surface curvature in accordance with Grotthuss chains.

PORTSMOUTH.

Mr. Shoolbred suggests in his report to the Portsmouth Town Council the low-tension system for private lighting with storage batteries, and the three-wire system for distribution, using armour-protected cables, laid underground, and embedded without any other covering whatever. The capacity of the electrical installation which he recommends to be laid down at first would be of a maximum output of 5,000 lights each of 16 c.p., burning at one time. This figure of 5,000 lights would mean a total of about 8,000 lights connected with the system of distribution. The buildings at the generating station should, however, be constructed large enough to contain without addition generating plant for about double the electrical output above mentioned, so as to allow for reasonable extension of the first supply. The boilers preferred are of the Lancashire type, steel and double-flued, working at 180lb. pressure per square inch. He recommends that steam engines of the inverted vertical type, running at moderate speeds, driving the dynamo direct, and placed in the same bed-plate therewith, be adopted. The sizes of steam engines which he recommends are those capable of developing 150 i.h.p. and 75 i.h.p. respectively. Should sea water for condensing purposes be not readily available (and it is not at present in central Portsmouth) the engines should be one of the compound non-condensing typo.

The capital expenditure for this part of the scheme is put at £45,000, and the revenue at £10,390, with a profit calculated to reach £1,451. We do not agree with Mr. Shoolbred's estimates—£10,390, with a maximum even of 8,000 lights wired, is rather more than we should expect, but as a rule the maximum number of lights estimated for are not wired for some years. For the public lighting Mr. Shoolbred suggests arc lights, the figures for which are: Cost of 25 lights on the Clarence Esplanade, 25 on the South Parade, with engines, dynamos, boilers, cables, lamps, and posts, etc., £5,500; 40 arc lights at refuges and other prominent points in streets named in the electric lighting order, with engines, dynamos, etc., £5,000; contingencies, 10 per cent., £1,050; making a total of £11,550.

The committee, having considered the general question of the electric lighting of Portsmouth, and inspected the systems in
vogue elsewhere, stated they were of opinion that
furnished by Mr. Shoolbred was the best t
adopted. They had come to the conclusion, aft
enquiry, that the low-pressure system was the mo
reason of its absolute safety and economy in
further advantage of this system was that it co
for motive power. In Mr. Shoolbred's report th
the installations for public and private lighting wa
£56,550; but to this should be added a sum for a
and meeting other expenses. The committee
that Mr. Shoolbred's report be adopted, and that
made to the Local Government Board for sanc
£60,000 for the purposes of the electric lighting

NOTES.

Tangiers Cable.—The inauguration of the cable from Tangiers to Tarifa took place on Tuesday.

Chatham.—The Chatham town councillors are thinking of having the Council-room lighted by electric light.

Old Students' Association.—Mr. W. B. Esson has been again nominated as the president-elect of the Old Students' Association.

Ipswich.—The arc light which the Ipswich Lighting Committee agreed to pay £15 a year to Messrs. Fraser, was started last Friday.

Glasgow.—Negotiations are pending by which the Glasgow Corporation is to buy the electric central station of Messrs. Muir and Mavor.

Electric Railways in Russia.—The first electric railway in Russia is being constructed at Kiev by the Allgemeine Electric Company of Berlin.

Dundee.—As will be seen by the full report elsewhere, the Dundee Gas Commission has resolved to spend £15,000 to £20,000 on a preliminary electric central station.

Darwen.—The Town Council of Darwen are spending £10,000 on improving their town. The present might be a favourable moment for introducing the electric light.

Paris National Library.—It is hoped that the Bibliothèque Nationale at Paris may be lighted by electricity during the coming winter. The Budget grant, however, has not yet been made.

Bradford.—At the Bradford Town Council meeting last week, Alderman Priestman stated that there was a loss of £30 on the working of the electric lighting department in the last half-year. He had no doubt that next half-year's working would yield a profit.

Electric Traction at Madrid.—The question of electric traction on the tramways is occupying much attention at Madrid, we understand. It is reported by the Spanish papers that one of the four tramway companies of Madrid is intending to instal the Gordon closed conduit system.

Malvern.—At the Malvern Local Board on Tuesday, a letter was received from Messrs. Griffiths and Millington, of Worcester, asking upon what terms the Board would be prepared to grant the right which had been obtained to supply the electric light. The decision upon the question was deferred.

Hand Dynamos.—We notice a neat and simple arrangement of hand dynamo made by Societa Elettrica Industriale, of Milan, which can be used for lecture experiments for charging small accumulators, lighting small lamps, or driving small motors. It is of inverted magnet type, giving opportunity for inspection of armature.

Testing Cables.—We notice that a useful work, entitled "A Practical Guide to the Testing of Insulated Wires and Cables," by Herbert Lawes Webb, member American Institute of Electrical Engineers, and of the Institution of Electrical Engineers, London, after having been published in America, is being also published in this country by Messrs. Spon.

Accident on the Portrush Electric Railway.—Two trams got upon the same line on the Giant's Causeway electric tramway last Saturday morning, and thinking the cars were going to collide, Mr. Hall and his wife, of Halifax, jumped from the car. The cars were stopped just as they touched. The lady was seriously injured, and the drivers were immediately arrested.

Tiverton.—At the meeting of the Tiverton Town Council last week, Mr. Grason said he was sorry the report of the Electric Lighting Committee had not yet been prepared, but it would be in their hands before the next meeting. Meanwhile it was thought desirable that the whole of the Council should pay an official visit to the electrical engineering exhibition at Taunton.

Munich.—The builder of the Cassel electricity works, Herr von Müller, has laid before the Munich municipal authorities his project for the utilisation of the water power of the Isar for electrical purposes. A preliminary force of 1,200 h.p. can be obtained, which will be used to produce rotary currents of 2,000 volts pressure. It is proposed to put transformers in each factory for alternate-current motors as well as light.

Electric Hand Fan.—Mr. William Luce, of Boston, is introducing a neat little invention for the ladies—a pendant to the electric cigar lighter—in the shape of an electric hand fan. The wings fold up and slip in the handle; on unfolding and connecting to a wall socket, pressure on a little knob sets the tiny fan rotating and sending "a gentle breeze to cool the glow of beauty's o'erflushed cheek."

Bradford Municipal Buildings. — Tenders are invited for carrying out works required in connection with the lighting by electricity of certain rooms in the Municipal Buildings, for the Bradford Corporation. Plans and specifications may be seen at the office of Mr. W. T. M'Gowen, town clerk, Town Hall, Bradford. Sealed tenders, endorsed "Tender for Electric Lighting," to be forwarded to the town clerk by 28th inst.

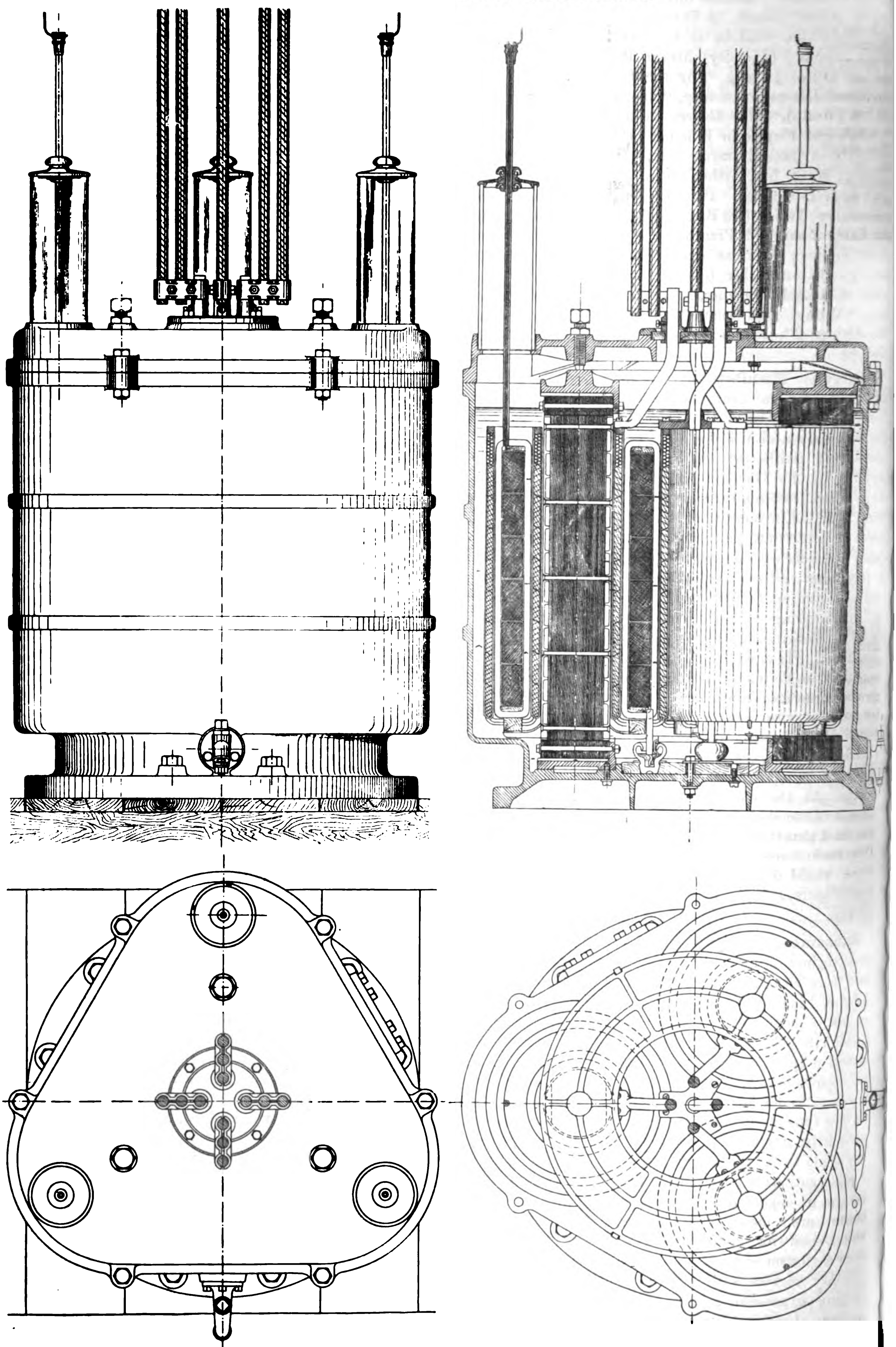
Proposed Electrical Exhibition in Glasgow.—The success which attended the Industrial Exhibition recently held in the East End of Glasgow had led to the suggestion, says the *Scotsman*, that an electrical engineering exhibition should be promoted in the same building during the winter months, and a prospectus has been issued setting forth the nature of the articles to be shown. One of the principal attractions would be Buffalo Bill's Wild West Show, which in any case will visit the district in November and remain till February.

Cologne.—The electric distribution from the new central station at Cologne is by alternate currents and transformers. The cables are buried in asphalte poured into wooden conduits. Herr Hegener, the director of this station, is greatly in favour of transformers as against accumulators. He states, in illustration of his views, that the efficiency of the accumulators in the Darmstadt station has dropped from 62·1 to 57·8 per cent. within a year. It is clear, however, that differences of manipulation might cause such variations from one year to another.

New Zealand. — The Town Council of Launceston, Tasmania, it is stated, proposes to introduce the electric light at an estimated cost of £50,000, to be g
water power at a distance of some three mil
has obtained an Electric Light Act, in whic
provision is inserted that the cost of electr
for public and private purposes, may be m
to exceed 7 per cent., in the way the wa
for in this country. Where the curren
not available, the rate is to be reduced

Electric Mining in South Afr
been made to use electric transmi

THE LAUFFEN-FRANKFORT TRANSMISSION.



OERLIKON HIGH-PRESSURE TRANSFORMER.

THE LAUFFEN-FRANKFORT TRANSMISSION.

In our issue of Aug. 28 will be found a description, with illustrations, of the Oerlikon apparatus for the transmission of power, except so far as regards the transformers. We are now, by the courtesy of Mr. C. E. L. Brown, enabled to supplement the previous information with other details. In the first place, there seems to be in some quarters a difficulty in comprehending the winding of the armature adopted. This point may be made clearer by an examination of the accompanying diagrams. There are three distinct windings upon the armature, represented diagrammatically in the sketch, Fig. 1. The shaded rectangles represent the poles, those, say, at the right-hand side being alternately S and N. The three circuits are represented by differently formed lines. The method of joining the three wires is shown in Fig. 2, wherein three ends are shown joined together, while the other ends are open, to be connected with the transformers or with the line. The three circuits are shown as being 120deg. apart one from the other. This corresponds to the actual method of connection.

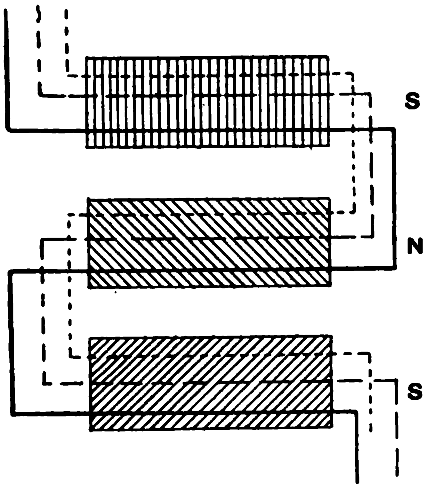


Fig. 1.

We further give on opposite page an illustration of the large high-pressure transformers employed in the Lauffen-Frankfort experiments.

The magnetic circuit is composed of three laminated iron columns of circular section, whose ends are connected by two flat laminated rings similar to a Brush armature core. Over each column are slipped the high and low tension coils. As the drawing clearly shows, the high-tension coil is boxed between the low-tension one. This disposition reduces the inductive drop, and simplifies the way of making the low-tension connections.

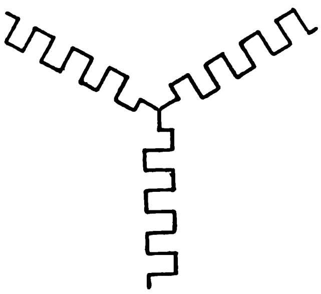


Fig. 2.

The construction of the whole transformer is such that any part of it can in a very short time be replaced. This transformer was designed to have an output of 200 kilowatts, and working with a normal pressure of 13 to 15 thousand volts. To ensure a very good insulation, the transformer is completely plunged in oil, but without this precaution the insulation is so good that the transformer can stand the high pressure of 15,000 volts, as has been proved by practical tests. The commercial efficiency at full load will be about 98 per cent.

In the early part of the year Mr. Brown read a paper at Frankfort on this subject, which appeared in the *Elektro technische Zeitschrift*, No. 11, an abstract of which we give elsewhere. It is somewhat generally thought that the multiphase current was the means of enabling the successful experiments at Frankfort. Mr. Brown says the multiphase current made the undertaking more difficult, as it involved many new complications in the dynamo, transformer, switchboards, and line. It was only chosen because of the possibility of driving self-starting motors without commutators.

ELECTRIC TRAVELLING CRANES.

The substitution of electric driving for other modes at present in use can be carried out upon any design of crane without necessitating important modifications. Excellent results are obtained, on the condition, of course, that the apparatus employed is carefully constructed and the arrangement is properly designed for the purpose required.

The application of electric motors to cranes has recently been carried out, says M. Desquieux, in the *Genie Civil*, by Messrs. Schneider et Cie. on several forms of their travelling cranes, notably upon a 60-ton crane used in their artillery works.

This crane was originally employed to serve a space of 50ft. wide and 330ft. long; worked by cables it could only raise 35 tons continuously with a speed of 2ft. per minute. With this load the speed of translation was 50ft. per minute. It was found that over 35 to 40 tons the rope slipped on all the pulleys and rapidly became charred. The life of the cable was hardly more than 10 months.

Recently the problem presented itself of making this crane serve 230ft. more, in all 560ft. The further use of cables could not be entertained, the inertia at starting being very considerably increased. It was necessary, therefore, to find other means of setting the gear in movement rapidly, and at the same time utilising the full power of the crane.

Very satisfactory results having been obtained with a travelling crane of 15 tons, it was finally decided to adopt as driving gear the electric motors of Ganz and Co., constructed at Creusot.

The following are the details of the arrangement: A Ganz continuous-current dynamo, type D 5, of 45,000 watts power, is fixed on the framework of the crane on the opposite side to the gearing, and drives the axle by a belt. The current is led from the dynamo by two bare cables of 12 mm. diameter, fastened at the two ends of the workshop and held up every 10 yards on porcelain pulleys; the current is taken off simply by two shoes fixed on the crane.

The accessory apparatus for starting and regulation, such as resistances, switches, ammeter, and voltmeter, are placed within the cage within the reach of the driver.

The current is produced by a dynamo, type D 5, of the same capacity as the motor. It also supplies current for a 15-ton crane carrying a D 3 motor, a wood-working shop which contains a D 3 motor, and several electric drills.

Under these conditions the crane raises with ease 40 tons with a speed of 7ft. per minute, and a load of 60 tons at 3ft. per minute. The speed of translation is about 90ft. per minute, so that to cross the entire space only requires about six minutes.

Owing to the method of exciting the dynamos, the voltage of transmission, which is 220 volts, remains constant, and the variations of speed of the motor empty and at full load do not exceed 5 per cent. Further than this no special precaution is taken for the running of the crane, and the maximum load is put on quickly without the least inconvenience.

Besides these advantages, the electric transmission has enabled an effective safety apparatus to be added to the crane gearing for the purpose of preventing any accidental fall of the chain in case of prolonged or involuntary de
This apparatus breaks the main circuit to the crane,
at the moment of descent is always weak, while yet
the dynamo excited, with the result of a very quick st

4. Provided with reliable stops to prevent carbons from falling out in case the clamps become loose.

5. Carefully insulated from the circuit in all their exposed parts.

6. Where inflammable material is near or under the lamps, provided with a wire netting around the globe, and a spark-arrester above, to prevent escape of sparks, melted copper, or carbon.

Incandescent lamps on series circuits, having a maximum potential of 350 volts or over, must be governed by the same rules as for arc lights, and each series lamp provided with a hand switch and automatic cut-out switch ; when lights are in multiple series, such switches and cut-outs must not control less than a single group of lights. Electromagnetic devices for switches are not approved.

Under no circumstance will incandescent lamps on series circuits be allowed to be attached to gas fixtures.

CLASS C.—INCANDESCENT (LOW PRESSURE) SYSTEMS. THREE HUNDRED VOLTS OR LESS.

Overhead Conductors.

Outside Overhead Conductors—Must be :

1. Erected in accordance with general rules for arc (series) circuit conductors.

2. Separated not less than 6in., where they enter buildings as service conductors, and be provided with a double-pole fusible cut-out, as near as possible to the point of entrance to the building, and outside the walls when practicable.

Underground Conductors.

Underground Conductors—Must be :

1. Provided with suitable protecting devices at the ends of tube or conduit services inside the walls of buildings, as a guard against moisture and injury.

2. Terminated at a properly placed double-pole house cut-out.

3. Of specially insulated conductors after leaving the tube or conduit, and separated by at least 10in., until the double-pole cut-out is reached.

Inside Wiring.

Wire should be so placed that in the event of the failure or deterioration of their insulating covering, the conductors will still remain insulated.

At the entrance of every building there shall be a double-pole switch placed in the service conductors, whereby the current may be entirely cut off.

Conductors—Must not be :

1. Of sizes smaller than No. 16 B. and S., No. 18 B.W.G., or No. 3 E.S.G.

2. Lead or paraffin covered.

3. Covered with soft rubber tube.

4. Laid in mouldings of any kind in damp places.

5. Laid in mouldings with open grooves against the wall or ceiling.

6. Laid in mouldings where less than half an inch of solid insulation is between parallel wires, and between wires and walls or ceilings.

Mouldings, where admissible, must have at least two coatings of water-proof paint or be impregnated with a moisture repellent.

Cleatwork is not desirable, and cleats must *not* be used unless :

1. In a very dry place.

2. In a place perfectly open for inspection at any time.

3. They are of porcelain, or well-seasoned wood, filled to prevent absorption of moisture.

4. They are so arranged that wires of opposite polarity, with a difference of potential of 150 volts or less, will be kept at least 2½in. apart, and that where a higher voltage is used this distance be increased proportionately.

5. There is a backing provided of wood at least ½in. thick, well seasoned and filled, to prevent absorption of moisture.

Metal Staples must never be used to fasten conductors unless :

1. Provided with an insulating sleeve or saddle rigidly attached to the metal of the staple, and having such strength and surface as to prevent mechanical injury to the insulation of the conductor.

2. Under conditions in which cleatwork would be acceptable, or where driven into a moulding specially adapted for open work.

Special Wiring.

Wherever conductors cross gas, water, or other metallic pipes, or any other conductors or conducting material (except arc light wires), they should be separated therefrom by some continuous non-conductor at least 1in. In crossing arc light wires the low-tension conductors must be placed at a distance of at least 6in. In wet places an air space must be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run over all pipes upon which condensed moisture is likely to gather, or which by leakage might cause trouble on a circuit.

In breweries, dye-houses, paper and pulp mills, or other buildings specially liable to moisture, all conductors, except where used for pendants, must be :

1. Separated at least 6in.

2. Carefully put up.

3. Supported by porcelain or glass insulators

Moisture proof and non-inflammable tubing may be accepted in lieu of such construction.

No switches or fusible cut-outs will be allowed in such places.

Interior Conduits—Must not be :

1. Combustible.

2. Of such material as will be injured or destroyed by plaster or cement, or of such material as will injure the insulation conductor.

3. So constructed or placed that difficulty will be experi removing or replacing the conductors.

4. Subject to mechanical injury by saws, chisels, or nails.

5. Supplied with a twin conductor in a single tube wh current of more than 10 amperes is expected.

6. Depended upon for insulation. The conductors m covered with moisture-proof material.

The object of a tube or conduit is to facilitate the insert extraction of the conductors, to protect them from mecha injury, and, as far as possible, from moisture.

Twin tube conductors must not be separated from each by rubber or similar material, but by cotton or other carbonisable substance.

Conductors passing through walls or ceilings must be in a suitable tubing, which must extend at least 1in. the finished surface, until the mortar or other similar ma be entirely dry, when the projection may be reduced to ½in.

Double-Pole Safety Cut-outs—Must be :

1. Placed where the overhead or underground conductors a building and join the inside wires.

2. Placed at every point where a change is made in the the wire (unless the cut-out in the larger wire will protect smaller). This includes all the flexible conductors. All junctions must be in plain sight.

3. Constructed with bases of non-combustible and moi proof material.

4. So constructed and placed that an arc cannot be maint between the terminals by the fusing of the metal.

5. So placed that on any combination fixture, no group of la requiring a current of six amperes or more shall be ultim dependent upon one cut-out.

6. Wherever used for more than six amperes, or where the or equivalent device is not used, equipped with fusible strip wires provided with contact surfaces or tips of harder me soldered or otherwise, having perfect electrical connection with fusible part of the strip.

Safety Fuses must be so proportioned to the conductors they intended to protect, that they will melt before the maximum carrying capacity of the wire is exceeded.

All fuses, where possible, must be stamped or otherwise mar with the number of amperes equal to the safe carrying capacity the wire they protect.

All cut-out blocks when installed must be similarly marked.

The safe carrying capacity of a wire changes under diff circumstances, being about 40 per cent. less when the wi closed in a tube or piece of moulding, than when bare and expo to the air, when the heat is rapidly radiated. It must be cle understood that the size of the fuse depends upon the size of smallest conductor it protects, and not upon the amount current to be used on the circuit. Below is a table showing safe carrying capacity of conductors of different sizes in Birming ham, Brown and Sharpe, and Edison gauges, which must followed in the placing of interior conductors.

Brown & Sharpe.		Birmingham.		Edison Standar	
Gauge No.	Amperes.	Gauge No.	Amperes.	Gauge No.	Ampere
0000	175	0000	175	200	17
000	145	000	150	180	16
00	120	00	130	140	15
0	100	0	100	110	110
1	95	1	95	90	[illegible]
2	70	2	85	80	[illegible]
3	60	3	75	65	7
4	50	4	65	55	6
5	45	5	60	50	60
6	35	6	50	40	50
7	30	7	45	30	40
8	25	8	35	25	35
10	20	10	30	20	30
12	15	12	20	12	20
14	10	14	15	8	15
16	5	16	10	5	10
—	—	18	5	3	5

Switches—Must :

1. Be mounted on moisture-proof and incombustible bases, su as slate or porcelain.

2. Be double-pole when the circuits which they control are con nected to fixtures attached to gas-pipes, and when six amperes o more are to pass through them.

3. Have a firm and secure contact, must make and break readily, and not stick when motion has once been imparted by the hand

4. Have carrying capacity sufficient to prevent heating above the surrounding atmosphere.

5. Be placed in dry, accessible places, and grouped as far a possible, being mounted, when practicable, upon slate or equally indestructible back boards.

Motors.—In wiring for motive power, the same precautions mu be taken as with the current of the same volume and potential fo lighting. The motor and resistance-box must be protected by a double-pole cut-out, and controlled by a double-pole switch.

Arc Lights on Low-Potential Circuits—Must be :

1. Supplied by branch conductors not smaller than No. 1 B. and S. gauge.

2. Connected with main conductors only through double-pol cut-outs.

3. Only furnished with such resistances or regulators as ar enclosed in non-combustible material, such resistances bein treated as sources of heat.

same way, and which are wrapped with iron tape in cases where such protection is required.

Telegraph Cables with Differently Insulated Cores.—Although offering nothing new to be seen, the usual iron wire sheathed telegraph cables with guttapercha and indiarubber cores, is supplied by the firm for a long time past both in and outside of Germany, could not be omitted from the collection. However, among them is to be seen an underground telegraph cable covered with flat iron wires for being drawn into conduits, where their lighter weight and smoother surface form an advantage. This cable is a new type.

For use in the tropics, indiarubber cables, which are better able to resist heat than guttapercha cables, are generally preferred to the latter; guttapercha at high degrees of heat softening and allowing the copper to get through the insuating covers. Felten and Guilleaume's impregnated fibre and paper cables behave in the same or even better manner than indiarubber cables, and are much cheaper than these.

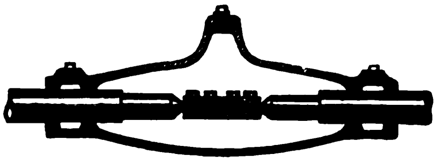


FIG. 6.—Joint-box for Single Cables. The copper cores are connected by means of clamps.

Of course, it is essential that impregnated cables be lead covered to render them impermeable against moisture, and according to local requirements an asphalted covering of yarn or tape, or even a sheathing of iron wire or iron tape, is necessary as a protection against mechanical injury. Even for guttapercha and rubber cables it may under special circumstances be necessary to insert a lead tube between the core and the sheathing, especially where, as in tunnels, the cables are exposed to chemically impure waters, or where they are laid in stagnant waters, and generally everywhere they are exposed to acids mixed with water, steam, or smoke, or to fouling substances. This precaution has, for instance, been used in the St. Gotthard Tunnel.

Electric Light Cables with various kinds of Insulation.—The various conditions under which light cables are employed, with regard to conductivity, insulation, capacity, low or high tension, mechanical strength, flexibility, and size, are of course to be taken into consideration in the choice of the insulating material and of the composition generally.

The samples exhibited represent cables with guttapercha and indiarubber insulation, as used in river crossings or in damp localities; further, cables with impregnated fibre and impregnated paper insulation, especially those for very high tensions; cables with copper cores consisting of proportionately thick wires, and those which, where, as in theatres, great flexibility is required, are composed of very fine wires.

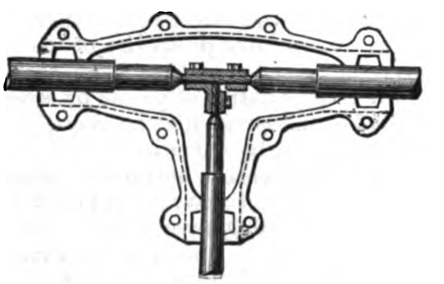


FIG. 7.—Branch-off Box for Single Cables. The copper cores are connected by means of clamps.

Telephone Cables.—With regard to mode of insulation the telephone cables do not show any marked difference from telegraph cables, except that in the former smaller copper wires are used, which are also insulated to a smaller diameter. Telephone cables are further characterised by the larger number of conductors in one cable and the special regards taken as to capacity and induction. Details have already been given how Felten and Guilleaume arrange these details in the construction of their telephone cables, for which the numerous samples exhibited bear eloquent testimony.

Torpedo Cables.—These cables have to answer many requirements which are often difficult to be complied with all at the same time. The choice of material and construction of torpedo cables are therefore very important. They must combine the smallest possible volume and weight with sufficient conductivity, insulation, and strength, and possess great flexibility. The insulating material must resist high degrees of heat without deterioration. In order to comply with all this, it is usual to compose the conductor of a great number of very small wires, partially of copper, partially of steel or bronze of high breaking strain. The insulating material is usually indiarubber; the exterior covering is made of yarn and braiding. Sometimes sheathing wires are applied, but then they are put on in the forms of strands or cords composed of very small steel wires.

Messrs. Felten and Guilleaume have for many years past supplied cables for military purposes to the Imperial German and other Governments. The great variation of the specimens shows how different the requirements to be complied with are.

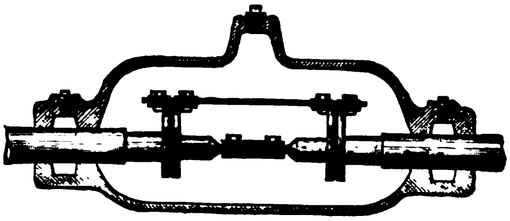


FIG. 8.—Joint-box for Concentric Cables, The inner conductors are connected by clamps, the outer conductors by clamps and rail.

The table placed near the entrance to Schuckert's show carries specimens of several raw materials—as guttapercha and indiarubber—in the different stages of preparation, as well as in the finished state ready to be used for insulating purposes. Six tableaux, arranged in the centre of this table, show the great variety of leads for house connections made by the firm—such as bare, cotton-covered, taped and braided guttapercha and rubber cores, waxed wires, arc and glow lamp connections, silk-covered wires, dynamo wires, suspension cords for arc lamps. This show is crowned by a specimen of light cable laid in the River Pregel.

On the left the first objects noticed on approaching are the Ferranti cables, exhibited by the firm, such as are used for the Deptford lighting installation at London. Every piece of sample bears a ticket with the explanation in German, English, and French. There are:

1. The inner conductor not insulated.
2. The inner conductor insulated.
3. The inner conductor insulated, with the outer conductor drawn over it.
4. The inner and outer conductors, both insulated.

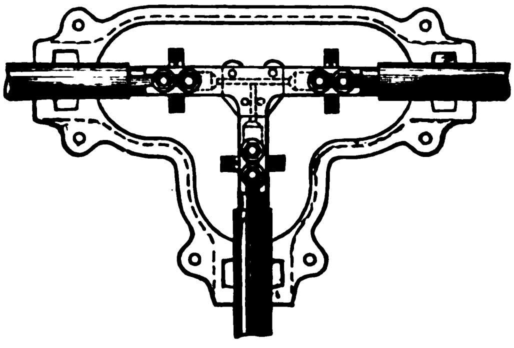


FIG. 9.—Branch-off Box for Concentric Cables. The inner conductors are connected by clamps, the outer conductors by clamps and rail.

5. The finished cable, with its protecting casing of iron.
6. A joint taken to pieces to show the conical preparation of the ends.
7. Another joint, also taken to pieces, partly finished, showing the manner of connecting the ends of the outer conductor by putting a copper sleeve over, which is fixed to them by corrugations.

Each of the two conductors has a copper section of 160 square millimetres, sufficient for a current of 250 amperes. The size of dielectric is calculated to suit a tension of 10,000 volts.

urse, at the joint, and no cheap contrivance at that point ould on any account be permitted. With girder or T rail nstruction it is, it seems to me, a useless expense to lay continuous supplementary wire. The rails should, of urse, be well and heavily bonded at the joints with iron, t copper wire, and cross connection of rails be frequently de. Where tram-rail track is used, I think a continuous re should be laid and connected with the bond wires.

The overhead wire cannot be too well put up. Cheap vices should never be used because they are cheap. The st and strongest are none too good. In putting up the d wire and putting in the ground wire return to the nerators, do not spare copper. I am convinced that uch that we have heard about the inefficiency of generators and motors is due to trying to get too great a uantity of current through too small a quantity of copper. the power station, do not make the units too large. ccidents will happen as long as machinery is run, and an cident to a 500-h.p. plant is serious; while you can keep our cars, or most of them, moving if one of two or three nall engines breaks down. The same rule, of course, olds as to the generators.

Always put in a condensing steam plant. One large item expense of operation is the coal bill. Cut that down at ast 40 per cent. by erecting condensing engines. The first st is, of course, a little more, but your stockholders, as ey examine your statements of operation in the years to ome, will say you were wise in your day and generation.

Locate your power station as near as may in the centre f your system, but above all, if possible, on a stream large nough to furnish all the water you require for the boilers nd condensers. City water, where your consumption runs nto the millions of gallons fast, is expensive.

It seems to me a mistake to equip a car body of greater ength than 18ft., and I think a 16ft. car is better still. During the hours of the day when travel is heavy, it is asy to pull a trailer, and when traffic is light, you are not hen using up your power in hauling around a great umbering double-truck structure practically empty.

A great many companies have had trouble with their motors. The chief reason for this trouble has been that their motors have been too light mechanically and too economically built electrically to stand the strain. All the manufacturing companies have learnt their lesson, and to-day most of the motors put upon the market are strong enough mechanically and electrically to perform, under proper conditions, the work expected of them.

The managers of electric roads, if they are to be made successful, must learn that the greatest earning power is no excuse for extravagant management, and that the difference between success and failure is often a narrow one. Everything depends upon taking the stitch in time. A loose belt, an imperfect connection, any one of 40 little things, may result in serious damage and consequent financial loss. I do not know of an electric railroad anywhere where the overhead single-trolley system is used which ought not to be successful. I know of some which have not been. In some cases cheap construction accounts for failure, and in some others careless management or reckless extravagance is the cause of the failure. The scrap heap about an electric car barn or machine shop often tells a significant story. Intelligent supervision and painstaking watchfulness is found one great secret of commercial success in this business, as well as in most others.

Every manager should keep a record of the items which go to make up operating expenses, and those responsible for management should carefully study these statements month by month with a view of lessening the expense of each item. An intelligent and careful examination of the cause of accidents to parts of a motor will often be the means of preventing the recurrence of troubles in the future.

So far as possible, motormen, as well as conductors, should be made to understand the mechanism of the machines which propel their cars and the function of each part. Thereby they are made ready to act promptly and intelligently in case of trouble with a motor.

The directors of some companies, because of their desire to make handsome returns to their stockholders, have paid out in dividends money which ought to have gone back into the road. The proper policy to pursue in all cases is the building up and bettering the plant out of earnings, so far as necessary, even at the expense of cutting down dividends.

The field in which we are working is a great one. There is in this field abundant opportunity for the intelligent, progressive, and sagacious business man. The primary object which the management of a street railroad seeks to attain is business success, but success in that direction cannot be had without great resulting benefits to the people of the community served by the railroad operated. We should not lose sight of the fact that we are engaged in a work the successful performance of which builds up communities, aids business enterprises, and makes the life of the people in those communities better worth living.

JOHN N. BECKLEY, Committee.

COMPANIES' MEETINGS.

BRUSH ELECTRICAL ENGINEERING COMPANY.

The second annual general meeting of this Company was held on Friday afternoon, September 25, at Cannon-street Hotel, the Duke of Marlborough presiding.

The **Secretary** (Mr. B. Broadhurst) having read the notice convening the meeting, and the report having been taken as read,

The **Chairman** said: It is a somewhat difficult position that occupy here to-day, having assumed the chairmanship of this Company for what I may call a broken year. I have had the pleasure of being connected with this Company now for, I think, three years. I have watched its progress, and seen the difficulties it has had to contend with. When we, unfortunately, lost the valuable services of our late chairman, Lord Thurlow, the Board were kind enough to ask me to carry on the business of the Company, as chairman, for the remainder of the year—and that duty I was very pleased to accept. Personally, perhaps, it is a fortunate circumstance for me that I am able to bring to your notice so favourable a balance-sheet as the one now placed before you. It is some—in fact, many—years since this Company has been able to feel that its position was one of what I may call commercial stability. The history of your Company is a peculiar one. As you are aware, it has been in existence for about 12 years—it was founded in 1879—and at that time there was an idea that the electric light was going to sweep all the gas companies straight away, and, in fact, completely revolutionise the conditions of our time and our industries. That anticipation was not fulfilled. We found out—as electricians could have told the public at the time—that hundreds of problems still remained unsolved, and that, not only with regard to the production of electrical energy, but also with regard to its distribution, it would take years before this industry (electric lighting) could be placed upon a commercial basis. In the inception of your affairs you had many valuable patents; those patents you sold for large sums, and your dividends were enormous. One year you absolutely paid a dividend of over 100 per cent. But it was not to be supposed that such a state of things as that could exist without turning men's heads, and making them go beyond the limits of prudent enterprise. The consequence was that in a very few years the Brush Company got into considerable difficulties, and Sir Henry Tyler, the then chairman, resigned. At that time Lord Thurlow became the chairman, and it really was a terrible time to have undertaken the chairmanship and the direction of the affairs of the Company. Not only were there the great difficulties occasioned by the discouragement which had been created by the failure of early promises, but there was the extraordinary difficulty which arose from the character of the early Electric Lighting Acts. These were of such a nature that when electric lighting came to be brought into a business position it was impossible to capitalise undertakings, there being no security to shareholders that they would not be bought out at a price that would leave them nothing for their money. To amend the Electric Lighting Acts was quite an undertaking. Your late chairman, Lord Thurlow, in conjunction with other gentlemen, was very largely instrumental in getting them amended, and in getting the present Acts passed. It is owing largely to these Acts that the electric lighting industry is possible in this country in the form of public lighting. We therefore owe our late Chairman a great debt of gratitude for having somewhat unobtrusively worked this matter through in the House of Lords, and for having carried on the affairs of this Company through four or five years of considerable depression—a time when we were unable to pay any dividend. And so m
went on until, as you are aware, it was necessary to bring
reconstruction of the Company. It had become nece
1884 to reduce the share capital by writing off a porti
and it was found necessary to combine the Australian
with our own. Lord Thurlow was largely instrumental in
about this reorganisation. This, and the amendment of th
Lighting Acts, was the turning-point in the affairs of the
The object of this Company is not to do small, or what I
retail work, but to carry out large industrial enterprise
trical energy has many features and many sides of u
There is electric traction and electric mining—in fact,

many engagements, to continue to give his personal attention he affairs of the Company. It is my duty now to move that the ort of the Directors and the statement of accounts to the 30th e, 1891, as now presented to the shareholders, be received, and same are hereby adopted.

r. J. B. Braithwaite, jun., in seconding the adoption of the ort, said that he entirely endorsed what the Chairman had said o the balance-sheet being a purely trading one. There was one penny of the profits made or to be made in connection h the City of London order included in it. These were all store for them in future years, and he thought they might k forward with satisfaction to future balance-sheets. One at change in this year's balance-sheet, which had been ried out at the suggestion of the auditors, and was a e one, was that a separate balance-sheet had been got of the foreign and colonial business. On the debit side their ital had been increased by the sum of £5,000, which was the aining payment they had to make to acquire the Australian siness. Then there was an item on each side of the balance- et in connection with the City of London business. On the oit side £34,892, which represented money received from the neer Company and other sources; and on the other side £21,070, ich at the date of that balance-sheet they had actually expended the City of London work. He was very glad to see on the debit e the beginning of a reserve fund (£4,275), though it was very all at present. It was a portion of the cash they had received the sale of property to the South-Eastern Railway Company d other sales. It would be the policy of the Board to increase at reserve as opportunity offered. The property account had en largely reduced, as compared with last year, and the tails were given in the report. Turning to the profit and s account, they would see on the credit side that their gross ofit, including a profit on foreign and colonial branches, nounted during the year to £39,915, and that in spite of the fact at their Managing Director and officers had had a good deal of eir time taken up with the City business. On the debit side ey would see that the standing charges had been reduced as mpared with last year. Every item almost showed a reduction. new item appeared under the head of staff bonuses, £759. He ped they would all agree with the policy of the Directors in this atter. It had been to give to every officer in the Brush Com- any, and ultimately they hoped to every man employed, an terest in the Company. In fact, they had adopted a rofit-sharing scheme, and so far as it had gone they had very reason to be satisfied with it. They commenced by lacing all the chief officers on that scheme. Then they were ble to extend it by electing another series of them, and this year hey would be able to extend it still further—viz., to all the oremen, and possibly to some of the men who had been longest with them. When they considered that the quality of their manu- actures depended upon the individual care of the workmen on mall pieces, it was not only right as a policy of justice to the men, ut it was a good policy as affecting their own (shareholders) nterests. To show how honest the balance-sheet was, he would call attention to the fact that, in addition to paying the dividend (6 per cent. on the ordinary shares, for which 7,018 had been appropriated), they had appropriated out f net profits for the year other items of an equal mount. This would show that if they had had any disposition to submit a false balance-sheet they could easily have lone so. They had written off £3,000 against property, and £630 gainst preliminary expenses. Then they carried forward a balance of £306. Against revenue they had written off the whole cost of the maintenance of their plant and buildings. They had written off the whole cost of maintenance of patents and the whole of the loss incurred in closing their Cardiff station. The closing of this station was not because it did not answer, but because the Corporation would not consent to the Company getting a provisional order, and the Board of Trade refused to allow them to carry on the lighting without one, so they had no option but to close the station. If the Corporation should ultimately decide to undertake the lighting of the town, they might come to the Company. It was not unlikely. These items amounted to another £7,045, so that they had written off against revenue an amount equal to that which they had distributed in dividends.

Mr. Smart objected to the wording of the paragraph as to dividends. Instead of 6 per cent. per annum for the half-year, it should be 3 per cent. for the year. He also contended that instead of lumping property, patents, and goodwill, etc., into one sum, property should be separated from goodwill and patents. He pointed out that after all the business that had been done, the gross profit was only 9 per cent. on the turnover of the Company.

Mr. Weir, as an original shareholder in the Brush Company, expressed his satisfaction at the condition of the Company. They appeared to have passed the experimental and to have arrived at the producing stage. He was glad they had adopted the profit-sharing scheme, and would congratulate the Company on having Mr. Garcke for a managing director. He asked if any progress had been made in the way of electric traction for tramways and light railways, and was their machinery adapted for such railways as were being constructed by the Government in the West of Ireland ?

The **Chairman**, in reply to the questions, said, as to the dividends it was a matter of personal liking as to how the wording went. As to the gross profits being only 9 per cent. on the whole capital of the Company, the concern had gone through very considerable vicissitudes, and they must remember that that capital, which would eventually earn a dividend, had been spent in building up the industry they now possessed. They had had heavy litigation and mistakes. But the industry promised to grow, and as it grew, it would carry all the money that had been spent in acquiring the experience they now had. The ratio of 9 per cent. would increase, and they would have less capital expenditure and larger returns. As to the property patents and goodwill item, that represented something that had been taken over by them from the old company *en bloc*. It was a bargain they had made, and they might as well put it down as one item and stick to it. They were very anxious to develop electric traction. They were carrying out one contract in Spain which they hoped would be a success. Mr. Mordey, one of their technical staff, had only lately returned from America, and had brought over details as to what was going on there. A large demand was likely to grow up for electric tramcars in outlying districts. The Falcon Works was originally a car-making concern, and this feature had been preserved, and they made cars there. They were going to try and obtain orders for tramcars and light railways in the future. He then put the motion adopting the report, and declared it agreed to.

The **Chairman** then proposed the declaration of a dividend of 6 per cent. on the preference shares, and 6 per cent. on the ordinary shares (*vide* report, p. 287 of our issue for the 18th September), payable on the 1st October, which was seconded and carried.

Mr. Van Tromp proposed the re-election of the Duke of Marlborough and Mr. Saunderson as directors, which was carried unanimously, as also was a motion for the re-election of the auditors, Messrs. Cooper Bros. and Co.

A vote of thanks to the Chairman concluded the proceedings.

CITY OF LONDON ELECTRIC LIGHTING (PIONEER) COMPANY.

An extraordinary general meeting of this Company was held at Winchester House, E.C., on Wednesday afternoon, the Lord Mayor (Sir Joseph Savory, chairman of the Company) presiding, to consider the question of voluntarily winding up the Company.

The **Secretary** (Mr. J. Cecil Bull) having read the notice convening the meeting,

The **Chairman** said it was his duty to tell them that the object for which that Company was formed had now been realised, and they had sold the concern to the City of London Electric Lighting Company for the sum of £75,000, clear of all deductions. He thought this must and would be satisfactory to the shareholders, and he felt no doubt that they would unanimously pass the resolution which was intended to be placed before them. Any questions that any shareholder might like to ask he would be very happy to answer. No questions being asked, his lordship said that he would formally propose that the Company be wound up voluntarily.

This was seconded by **Mr. J. B. Braithwaite, jun.**, who thought they would be fairly well satisfied with the result of their investment in the Pioneer Company, and still more satisfied that they had succeeded in their object, which was to form a company which should undertake the efficient lighting of London. Their company stepped into the breach last February and initiated the proceedings, and the financial arrangements for the lighting work having been made he had only to congratulate the shareholders on the fact that the formation of the City of London Lighting Company had been successfully carried out. The shareholders would receive back the money they had embarked in the Company, with a bonus of 50 per cent. (Each shareholder receives his original capital of £50 per share with a bonus of £25.)

The resolution was carried unanimously.

The **Chairman** then said that he had only to add that the extraordinary general meeting confirmatory of the one he was addressing, would be held in about a fortnight, and the cheques to the shareholders would be made out as soon as possible after that meeting.

Mr. Edward Lee proposed a vote of thanks to the Chairman and Directors for their services, remarking that it had been mooted about that lord mayors had no right to put their names on prospectuses, or even to become directors of public companies. But that was an exceptional case. The Lord Mayor, as head of the City, did what he could to aid the Board of Directors of this Company, which was for the benefit of the entire City of London.

Mr. McGeagh seconded the vote, and it was carried unanimously.

The **Chairman** said he was extremely obliged for the vote on his own and his colleagues' behalf. It was his firm resolution when he entered on his public office to join no company, and it was only exceptional reasons, and pressure brought to bear upon him from very high quarters, that induced him to so far waive his resolution as to join that Company. He could assure them it was a satisfaction to be able to announce that the work they had in hand had advanced so far satisfactorily, and that they had so far protected the interests of their shareholders.

DIRECT SPANISH TELEGRAPH COMPANY.

The thirty-sixth ordinary general meeting of this Company was held on Tuesday at Winchester House, E.C. Mr. Edmund Etlinger presided, in the absence of Sir James Anderson, who has recently sustained a severe domestic bereavement.

The **Chairman** observed that the statement in the report, that the receipts showed a decrease of £1,620 as compared with those of the June half of 1890, did not quite do justice to the position of the Company; and proceeded to explain that the receipts for the half-year under review had been larger than they had been in any similar period since the beginning of the Company in 1873, with the sole exception of last year. The shareholders might, therefore, be satisfied that the Company was in a very nown about magnetism, and we look in vain for any ideas rom him. This great philosopher, who stated the laws hich govern the motion of bodies, and many other laws, o clearly that they are accepted now just as he enunciated hem, felt incompetent to offer any explanation of magnetic henomena; and Gilbert, with whose name is associated he first we hear of the science, contented himself with a leclaration of the phenomena he observed.

Poisson and Coulomb seem to have been the first to rame a theory, and almost all subsequent theorists have greed with them to this extent, that magnetism has a molecular nature.

They assumed that each molecule is a sphere, containing two distinct magnetic fluids, which are separated under the influence of magnetic force, and that a certain inherent coercive force keeps the two fluids from mixing in the case of a permanent magnet. Such a theory explains the inductive action which takes place between magnets and magnetic bodies, but not much more.

Sir Wm. Thomson was perhaps the first to express his disbelief in these fluids in 1849, and he established a mathematical theory founded mostly on Coulomb's researches.

Weber's theory is an improvement on Poisson's, and his views were good enough to be entertained by Clerk Maxwell with certain modifications. He held that each molecule of iron is a magnet before any application of magnetising force, and that the axes of the molecules are turned in all directions; that the axes were deflected towards parallelism by a magnetising force; and that each one tends to return to its initial position.

This theory would account for saturation and for some of the effects of temperature, but does not explain retentiveness, and is silent about the connection between the magnetic and other properties of iron.

Clerk Maxwell agreed with Weber in his explanation of neutrality, but offered an explanation of retentiveness based on the analogy of magnetism to mechanical strain. To use his own symbols, he supposes that when a molecule is deflected by a magnetising force, X, it returns to its initial position when X is removed, if the angle of deflection, β, of its axis has been less than a certain limit, β_0. If, however, β_0 has been exceeded, it does not completely return, but remains with its axis deflected through an angle $\beta - \beta_0$.

But under these circumstances, as Ewing[*] pointed out, we should expect, on sudden reapplication and withdrawal of X, to obtain a purely elastic series of changes, so that this modification and extension of Weber's theory does not allow of the existence of hysteresis.

Ampère's theory is at first sight very plausible, and goes a little further than any other theories before or since in stating what the magnetism of a molecule actually consists of. It is based on the analogy of electric currents, and supposes that an electric current flows round each molecule in a closed circuit of no resistance, and that neutrality is due to a miscellaneous, and magnetisation to a symmetrical, arrangement of the molecules.

This theory has this advantage—shared by no other—that it readily accounts for many of the observed connections between magnetism and electricity; but a serious objection is that, as far as we know, electric currents cannot exist without a constant expenditure of energy, and in any case we do not know what an electric current consists of.

De la Rive, in 1853, held Weber's views concerning the inherent magnetism of every molecule, and the cause of neutrality; but he recognised retentiveness, and assigned it to the resistance of the molecules to change their relative positions, calling this resistance "coercitive force."

Wiedemann in his "Galvanismus" gives a molecular theory, which is in some respects the same as that held at the present day. In that work he states, and was probably the first to do so, that neutrality consists of a symmetrical arrangement of the molecules. Hughes lays claim to the first assertion of this condition of neutrality. Into the question of this priority I do not propose to enter further. In any case, Hughes in 1883 formulated a very complete theory of the physical conditions which accompany the states of neutrality and polarity, and since these assumptions, as far as they went, constituted for many years the current creed, I think they are worth stating in full.

"1. That each molecule of a piece of iron, steel, or other magnetic substance, is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed in a steel bar magnet.

"2. That each molecule or its polarity can be rotated in either direction upon its axis by torsion, stress, or by physical forces, such as magnetism and electricity.

"3. That the inherent polarity or magnetism of each molecule is a constant quantity like gravity, that it can be neither augmented nor destroyed.

"4. That when we have external neutrality, or no apparent magnetism, the molecules, or their polarities, arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circle of attraction.

5. "That when the magnetism becomes evident, the molecules, or their polarities, have all rotated symmetrically in a given direction, producing a north pole if rotated in one direction as regards the piece of steel, or a south pole if rotated in the opposite direction. Also, that in evident magnetism we have still a symmetrical arrangement, but one whose circles of attraction are not completed except through an external armature joining both poles.

"6. That we have permanent magnetisation when the rigidity, as in tempered steel, retains the molecules in a given direction, and transient magnetism whenever the molecules rotate in comparative freedom, as in soft iron."[*]

The last clause is not quite correct in the light of Ewing's later experiments on the ratio of residual to induced magnetism, inasmuch as soft iron is undoubtedly more retentive than tempered steel; and clauses 4 and 5 may also require considerable modification, but, nevertheless, much praise is due to Hughes for the manner in which he placed some of the physical accompaniments of magnetisation almost beyond the region of speculation, by his very ingenious and indefatigable applications of the induction balance, and for the way in which, before bringing forward this theory, he submitted the statements in it to experimental demonstration, by a method of investigation which had been impossible before the introduction of the balance.

Ewing's experiments on hysteresis and retentiveness, though they do not form the basis of a new theory, are of great service in exposing the weak points of previous theories, especially those of Weber and Maxwell. When he recorded the results of those experiments[†] he at the same time stated that to form a mechanical conception of the process of magnetisation, it is necessary to assume an elastic tendency on the part of the molecules to recover their initial position when displaced; a static frictional resistance opposing such displacement; and also a viscous resistance to the displacement—these three assumptions being intended to account for residual magnetism, hysteresis, and time-lag respectively.

But quite recently Ewing's own views have undergone considerable change, in consequence of experiments which he made with a model intended to illustrate the actual movements of the molecules of magnetic bodies, and in a paper describing these experiments, which he read before the Royal Society, June 19, 1890, he says that although the motion of a frictional resistance to displacement of the molecules accounts well for hysteresis, and its reduction by vibration, it opposes the fact that some magnetism is induced even by the feeblest magnetising force. He then proceeds to work out a theory the essence of which is, that it is not necessary to suppose that any forces are constraining the molecules, except those due to their own mutual attractions and repulsions, which are quite sufficient to account for the directional stability of the molecules.

Such a theory accounts well for effects of stress, temperature, vibration, etc., upon magnetic quality. It attributes hysteresis to the transition of a system of molecules from one position of rest to another through an unstable condition. It explains why, even when there is cial screw clamps of galvanised iron. The insulators are the form shown in Figs. 33 to 35. They are furnished the upper surface with two lateral projections moulded

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[*] *Phil. Trans.*, 1885.

[*] *Proc.* Roy. Soc., vol. 34.

[†] *Phil. Trans.*, 1885.

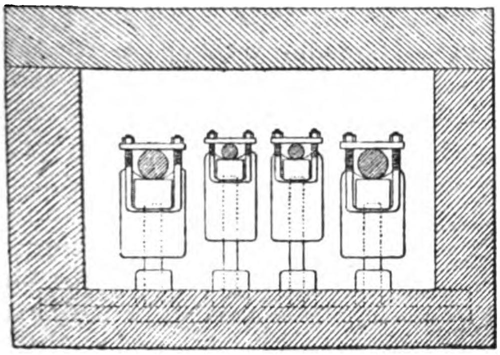

Fig. 31.

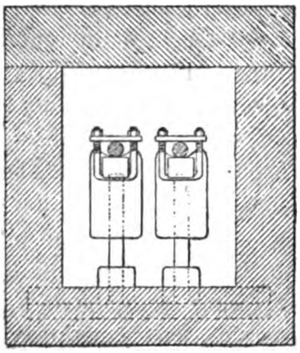

Fig. 32.

on the body, and ribbed on their lower surface to receive the horizontal bar of the clamp. The cable is firmly fixed, by means of screws, to the head of the insulator. This arrangement is a modification, brought about by the inconveniences experienced in the first type of insulators, Figs. 31 and 32, where the square lug was apt to be broken off by unequal tightening.

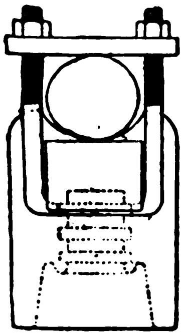

Fig. 33.

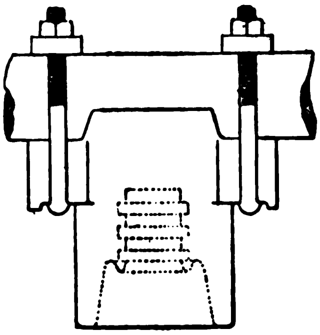

Fig. 34.

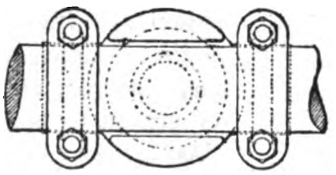

Fig. 35.

(To be continued.)

DRAWING IN CABLES.

The minor improvements in apparatus frequently are of great assistance in saving labour and trouble. We herewith illustrate a piece of apparatus of the kind, which is simple, cheap, effective, and saves a good deal of trouble and money, not to speak of the less frequent misuse of hard language.

When drawing electric cables into pipes, Callender-Webber cases, or other conduits, it is necessary to make a secure connection between the cable and the rope by which it is to be pulled in. It is also necessary that such connections should be small enough to pass through the pipe or case. The method usually adopted at present is to make a splice by cutting out the centre strands of the conductor and "marrying" the outer strands to those of the rope. The grip designed by Mr. Voysey avoids this waste of time and material. It consists of a small ferrule, 2in. or 3in. long, tapered inside, and made so that the narrow end fits closely to the conductor for the cable. The ferrule is placed on the end of the conductor, narrow end foremost, the insulation being cut back 2in. or 3in., according to the length of the ferrule. When in position, a tapered pin is driven into the centre of the cable, and this spreads the strands so as to make the ferrule grip more tightly the more it is pulled.

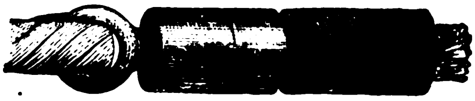

Fig. 1.

On to the end of the rope is permanently connected a small cap, which is then screwed on to the ferrule. Thus, in two or three minutes, a joint (of smaller diameter than the cable) can be made capable of sustaining any strain required. After the cable is drawn in the ferrule can be easily removed by taking out the tapered pin, which is provided with a small head, so that it can be knocked out without difficulty. It has also great advantage over an ordinary splice, which may "ruck up" when being drawn over sharp bends. The saving of expense and time may be shown by giving the cost of the present method. Let us take a $^{91}/_{11}$ cable, and the cost is as follows:

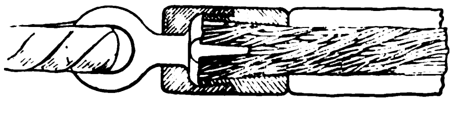

Fig. 2.

	s.	d.
Jointer, 1½ hours making and unmaking splice ...	1	0
10 men one hour awaiting same	5	0
1ft. 6in. cable..	11	6
Rope waste, tape for covering splice, etc.............	0	6
	18	0

The grip has been successfully used in drawing in cables into Callender's casing, and its action is perfect. It has a great advantage over the ordinary splice when drawing round sharp bends. It has been estimated that the cost of preparation for drawing in a $^{91}/_{11}$ cable is about 18s., or if the men hauling can be elsewhere employed, and have not to wait on the jointer, at 13s., the greater part of this being due to destruction of cable. With the patent grip a joint is made in a couple of minutes or so, instead of in as many hours, and the waste of cable is exceedingly small. The grip is made of bar steel, so as to have it as strong as possible. The accompanying figures explain themselves. Fig. 1 shows the grip as fastened to the cable. Fig. 2, a section when so fast; and Fig. 3, the various parts in position.

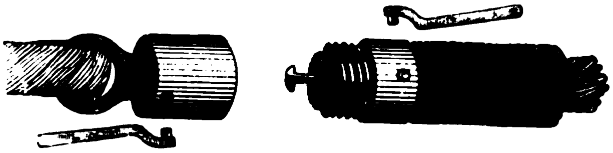

Fig. 3.

ch ·15 millimetre diameter (about No. 34 gauge), 6ft. 6in. length, stretched between the first two poles. The hole of the 300 h.p. passes through these six thin wires. t every railway station along the line is a stout length of opper wire of V-shape inverted, hung over the three wires, which can be dropped, and so blow the fuses should necessity arise.

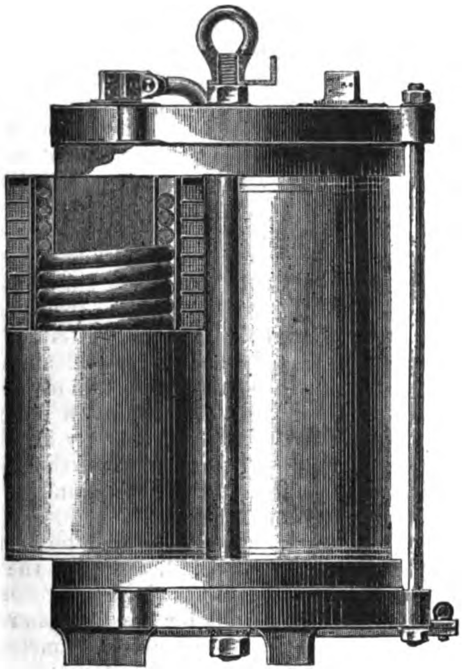

FIG. 3.—Lauffen Transformer. Sectional Elevation.

THE PROFESSION OF ELECTRICAL ENGINEERING.

BY H. CUTHBERT HALL.

If a young man, or youth leaving school, wishing to become an electrical engineer, seeks advice as to what course he shall pursue in order to achieve the desired end, he is usually told that one of three courses is open to him, either of which is calculated to provide him in a greater or less degree with the equipment which he needs.

If he is pecuniarily well off, he may go to a university and study mathematics and, perhaps, the theory of electricity, and then proceed, on leaving the university, to attach himself to a firm of electrical engineers as an articled pupil, there gaining that practical knowledge of his profession which his university training will enable him to receive to the greatest advantage. Or he can, without any special theoretical training, join a firm immediately on leaving school and endeavour to acquire such theoretical knowledge as is attainable after his day's work in the factory is done The third alternative which is open to him is to join one of the numerous technical colleges which profess to combine theoretical with practical training, and to turn out efficient engineers after a one year's, two years', or three years' course.

Of these three courses the former is undoubtedly the best, as by following it a man is enabled to acquire both theoretical and practical training under the most favourable conditions. The second course probably comes next in order of merit, but the theoretical training is necessarily placed at a great disadvantage by the fact that it has to be pursued when the student is wearied with physical labour. The third course is perhaps the least advantageous of the three, as in the endeavour to simultaneously acquire practical and theoretical knowledge the student not infrequently fails in satisfactorily acquiring either the one or the other.

Whichever course, however, is ultimately decided upon and pursued, involves the expenditure of a good deal of time and money, and the person in question not unreasonably looks forward to receiving, at the end of his apprenticeship, a return in some measure proportioned to the trouble and expense which he has incurred. But in this respect he is, in nine cases out of ten, most grievously disappointed; for some of the best firms of electrical engineers are not ashamed to offer men of exceptional education, ability, and training, salaries which would be regarded as poor by the average City clerk.

To the uninitiated it would seem incredible that in order to properly qualify for the position of electrical engineer it should be necessary to spend several years in preparation without receiving any pecuniary advantage, and to have to go to the expense of paying a premium and college fees, and that at the end of the term of preparation a salary should be offered very little higher than would be paid to a raw youth, fresh from school, on entering a commercial house. As an instance of what frequently occurs, the career, based on actual facts, of an electrical engineer may be cited, and may, perhaps, prove not uninteresting. It is briefly summed up as follows: Preliminary education at a public school; proceeded to Cambridge; came out in the mathematical tripos a fifth wrangler; spent three years as an articled pupil at a well-known firm of electrical engineers; became, on expiration of term of articled pupilage, a member of their staff, at a salary of £100 per annum. Cost of three years at Cambridge, about £800; premium to firm of engineers, £300; salary received after six years' training, £100 per annum.

Now here is the case of a man of considerable ability, as proved by the degree which he took, laying out over £1,200 in preparation, and after six years receiving a salary of only £100 per annum. And this is no exaggerated case, but quite as good, if not better, than is the fate of nine out of every ten.

In reply, it may be urged that the profession offers many prizes, which really first-class men obtain; but this is not the case, for positions in England worth over £500 per annum are decidedly exceptional.

A short time ago an important town in the West of England advertised for an electrical engineer to take charge of the central lighting station there, and in order to obtain so important a position a man would certainly have had to have been able to claim a considerable experience of this class of work, nor would it have been of much use for a very young man to offer himself for the post; yet for this important position the paltry salary of £300 per annum was offered. A director of several large electric lighting schemes recently admitted in conversation that he was surprised to find for what low salaries really efficient men could be obtained, and the enumeration of instances might be multiplied of men holding important positions in connection with electric lighting schemes and firms of electrical engineers, at a remuneration which would be considered insufficient for a responsible man engaged in a branch of commerce which required no technical training or education above that afforded by the Board schools.

In the case of electric lighting schemes some slight excuse may be offered for the payment of such low salaries, because in so many instances no dividend has been earned, but where a firm of electrical engineers and contractors is in question it is notorious that large fortunes have been made of late years, and similar excuses cannot therefore be offered by them for the underpaying of their employés which so frequently exists.

The reasons for the exceptionally bad position of electrical engineers, as compared even with other classes of employés, are several in number, and, perhaps, even a cursory inspection of them may suggest at any rate a partial cure.

The profession has undoubtedly many advantages. The immunity which it offers from the drudgery of the desk is a great attraction to many, and the fact that applied electricity, as a science, is comparatively in its infancy, induces many to join the ranks of electrical engineering who would feel little interest in more beaten tracks. But in one sense this very attractiveness is a bane of the engineer, for many men are, at any rate, partially reconciled to receiving insufficient salaries because of their fondness for the work. But the primary cause of the low salaries which are paid is undoubtedly to be found in the fact that no test is imposed by any responsible body on those who wish to enter the profession. In fact, anyone can call himself an "electrician," from the local ironmonger upwards. The consequence is that the profession is crowded with a number of incapables, whom

> of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the work; that the cover-stones of the culverts under 20in. wide shall be not less than 2in. thick, and of the wider culverts not less than 2½in.; and that where the culvert crosses the carriageway, there shall be at least 9in. thickness of Portland cement concrete above the cover-stones of the culvert, in addition to the road material.

We have considered two notices from the Westminster Electric Supply Corporation, one dated 25th August, 1891, of intention to lay mains in Sussex-street, Cumberland-street, and Westmoreland-street, and the other, dated 9th September, 1891, of intention to lay mains on the west side of Regent-street, from Conduit-street to St. George's Church. The proposed works are unobjectionable, and we recommend:

> That the consent of the Council be given to the works referred to in the notices, dated 25th August and 9th September, 1891, respectively, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works; that the mains be laid under the footways wherever it is found practicable to do so; and that the covers of the street boxes to be used shall consist of iron frames filled in with material to suit the paving.

The House-to-House Electric Light Supply Company has served a notice, dated 1st September, 1891, of intention to lay a main across Earl's Court-road at Earl's Court-gardens. There seems to be no objection to this proposal, and we recommend:

> That the sanction of the Council be given to the works referred to in the notice, dated 1st September, 1891, of the House-to-House Electric Light Supply Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the work; that no pipes of a larger diameter than 6in. shall be used; that the street boxes to be used shall be of the pattern approved by the Council; and that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, each insulated from the other as far as practicable, and that the outer cover shall be efficiently connected with earth.

A notice, without date, was received on the 2nd of September, 1891, from the Kensington and Knightsbridge Electric Lighting Company, of proposed extension of mains in Brompton-road, from Montpelier-street to Fulham Bridge-road. These works are of the ordinary character; and we recommend:

> That the sanction of the Council be given to the works referred to in the notice, without date, of the Kensington and Knightsbridge Electric Lighting Company.

The London Electric Supply Corporation has given a notice, dated 5th September, 1891, of intention to lay two lines of distributing mains, consisting of concentric lead-covered cables in iron pipes, in Tooley-street and Montague-close, Southwark. There appears to be no objection to what is proposed, and we recommend:

> That the sanction of the Council be given to the works referred to in the notice, dated September 5th, 1891, of the London Electric Supply Corporation upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works; that the mains be laid under the footways, and be kept 9in. below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected where leaving the boxes by an extra lead covering, or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable in good connection with the lead or iron outer casing; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps in addition to any other covering.

We have considered two notices, dated September 1st and 11th, 1891, respectively, from the St. James and Pall Mall Electric Lighting Company of intention to lay mains (1) across Regent-street, to complete the scheme of mains approved by the Council, and (2) to connect two mains in Regent-street already authorised. The works referred to are of the usual character, and there appears to be no objection to them. We recommend:

> That the sanction of the Council be given to the works referred to in the two notices, dated September 1st and September 11th, 1891, respectively, of the St. James and Pall Mall Electric Lighting Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works, and that the works in Regent-street shall, when commenced, be carried on continuously by day and night until completed.

A notice, dated September 23rd, 1891, has been given by Mr. H. Robinson, on behalf of the Vestry of St. Pancras, under the St. Pancras (Middlesex) Electric Lighting Order, 1883, of intention to lay mains in Park-street, Camden Town, Gordon street and square, Woburn-square, Tavistock-square, Endsleigh-street, and Upper Woburn-place. The proposed works are similar to those previously approved by the Council in the application of the Vestry, and seeing no objection to them, we recommend:

> That the Council do approve the works referred to in the notice of the Vestry of St. Pancras, dated September 23rd, 1891, under the provisions of the St. Pancras (Middlesex) Electric Lighting Order, 1883.

We have considered a notice dated September 24th, 1891, from the Metropolitan Electric Supply Company, of intention to lay mains in Kildare-terrace, Talbot-road, Westbourne Park-passage, Orchard-street, Alfred-road, Bradley place and street, Harrow-road (part of), and Amberley-road (part of). The proposed works are of the same description as those of this company previously sanctioned by the Council, and there seems to be no objection to them. Part, however, of the route to be traversed by these mains consists of narrow alleys, and the company should be required to provide that a thoroughfare shall be kept there while the works are in progress. We recommend:

> That the sanction of the Council be given to the works referred to in the notice dated 24th September, 1891, of the Metropolitan Electric Supply Company, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works; that provision be made for the works to be carried out in the narrow ways included in the notice without stoppage of the traffic; that the mains be enclosed in iron pipes or efficient casing, and be laid under the footways wherever it is found practicable to do so; that as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover, which shall consist of an iron frame filled in with material to suit the paving, shall be efficiently connected to earth.

We have also to report the receipt of the following notices given in accordance with the resolution of the Council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:

From the St. James and Pall Mall Electric Lighting Company: July 30th, to 8, Pall-mall, and 50, Glasshouse-street; August 21st, to 7, New Burlington-street, 174, Piccadilly, 163 and 230, Regent-street; August 26th, to 77, Jermyn-street, 10, Sackville-street, and 10, St. James's-square; September 1st, to 182, 218, and 232, Regent-street; September 8th, to St. James's Palace, and to 167, 193, 230, and 232, Regent-street; September 11th, to 90, 198, and 206, Regent-street.

From the Electricity Supply Corporation: 31st July, to the St. Martin's Vestry Hall, Charing Cross-road; 29th August, to 4 and 6, Charing Cross-road; 21st September, to 29, Spring-gardens.

From the Westminster Electric Supply Corporation: 28th July, to 11, Halkin-street West, and to 13, Half Moon-street; to 1, St. George's-road (no date).

From the London Electric Supply Corporation: 24th July, to 146, Borough High-street, and to 77, Southwark-street; 25th July, to 121A, Regent-street, and 41 and 42, Parliament-street; 29th July, to 235, Westminster Bridge-road, and to Garrick-chambers; 31st July, to 143, 413, and 487, Oxford-street; 18th August, to Hibernia-chambers; 20th August, to 43, Upper Brook-street, and 47, New Bond-street; 21st August, to 2, Tooley-street, and to 62, South Audley-street; 28th August, to 233, Borough High-street; 2nd September, to 24, Haymarket; 25th September, to 23, Haymarket, and to 1, Rupert-street.

Electric Testing Station—Meter Inspector.

We have to report, for the information of the Council, that Mr. W. Arnot, who was appointed in February, 1890, at a salary of £200 a year, to act as an inspector under the Electric Lighting Orders and Acts, has resigned his appointment, he having been appointed electrical engineer to the Glasgow Corporation. We have made temporary arrangements for the discharge of the duties, and propose at a future time to advise as to the manner in which the vacancy shall be filled.

NEW COMPANIES REGISTERED.

Atlas Carbon Manufacturing Company, Limited.—Registered by Slaughter and May, 21, Great Winchester-street, E.C., with a capital of £2,000 in £1 shares. Object: to manufacture and deal in electric conductors and non-conductors, machinery, plant, apparatus, instruments, fittings, etc., used in connection with the generation and distribution of electricity, and, with a view thereto, to adopt an agreement expressed to be made between W. J. Woodward of the one part and the Company of the other part. Registered without articles.

Law's Electrical Appliances Company, Limited.—Registered by Davidson and Morriss, 40 and 42, Queen Victoria-street, London, E.C., with a capital of £4,000 in £5 shares. Object: to carry into effect an agreement expressed to be made between Edward Fitzgerald Law of the first part, C. T. D. Crews, Sinclair Macleay, J. T. F. Otway, W. H. James, and E. F. Law of the second part, and this Company of the third part: and also to adopt and carry into effect another agreement expressed to be made between William Clowes and Sons, Limited, of the one part and this Company of the other part; and generally to carry on business as type-setters and compositors (by machinery or otherwise), printers, lithographers, telegraphists, newsagents, advertisfor of the five-wire system in England, the Manchester tion will have great interest for electrical engineers.

Consulting Engineers.—Messrs. Morgan Williams d Frank King, whose commencement as consulting gineers we announced last week, are acting in this pacity to the Sydenham electric lighting station, now ing carried out by Messrs. J. E. H. Gordon and Co., imited. We believe they are also engaged in investigating d reporting upon a scheme for lighting a tunnel two iles long on the Rhondda and Swansea Bay Railway, and r lighting the trains by the use of neighbouring water wer.

St. Helens.—Tenders are invited for erection of rtain appliances and machinery for the supply of elec- icity to the Town Hall, St. Helens. Plans may be seen d specification and form of tender obtained on application Mr. G. J. C. Broom, A.M.I.C.E., the borough engineer, payment of one guinea, which will be returned on ceipt of a *bona fide* tender. Sealed tenders to be sent in y 21st inst., addressed to the Chairman of the Parks, arkets, and General Purposes Committee, and endorsed Tender for Electric Light, Town Hall."

Blackpool.—The Blackpool town councillors are deter- ined to do something practical with reference to the lectric lighting question at once. At the last meeting ouncillor Pearson was appointed chairman of the Electric ighting Committee, and it was resolved that a short state- ent of particulars of electric lighting in selected towns be repared under the directions of the chairman, Councillor ergenson, and the town clerk; also that those members of he committee who can make it convenient should visit the owns so recommended by the sub-committee.

Fatal Accident at Lauffen.—We regret to learn hat on Monday one of the engineers employed at the auffen generating station met with a fatal accident through ouching a wire through which a high-tension current was passing. The deceased, whose name was Rau, was discovered lying dead on the floor of the transformer-house by the engineer-in chief. It appears that Rau, in defiance of the instructions given him, entered the transformer-room to attend to a defective lamp, and coming into contact with a high-tension wire was killed instantaneously.

Jensen Electric Bells. — We are informed by Messrs. Woodhouse and Rawson United, Limited, that Messrs. Hans Jensen and Jens Jensen, hitherto branch managers of the business carried on at 2, Gray's-inn-road, under the name of the Jensen Bell and Signal Company, are no longer connected with the company directly or indirectly. The whole of the patents are the property of Woodhouse and Rawson, and the bells will continue to be manufactured as before. It is intended to remove the business to the Cadby Hall Works, Kensington.

Telephone Charges.—A correspondent in the *Scotsman*, referring to the application of the Caledonian Telephone Company, of Glasgow, for a license from the Post Office to run telephone exchanges, expresses a hope that the license will be granted, as the public will then have the advantage of cheapness and efficiency, these coming with competition. He mentions that in Paisley an exchange connection is obtainable for £5 a year, and where two people use the same wire, each having their own instrument the expense is the mere trifle of £3 a year each.

Ulverston.—The Ulverston Local Board would probably be grateful for a little definite information as to the cost of electric lighting. It is necessary to do something to keep their provisional order, but they do not wish to absorb the dwindling profits of the gas works. One member expressed an opinion that electric plant for Ulverston would cost £100,000! With the use of water power one or two thousand should do a great deal. The clerk is to communicate with the Board of Trade, and report again as to the steps to be taken to put the provisional order in force.

Teaching Languages by Telephone.—What are we coming to next? The question of teaching languages must indeed be pressing, if what is stated is not a joke. The French Minister of Public Instruction—noting that in learning English it is the pronunciation that is the most difficult part—has decreed, in accordance with arrangements made with the Minister of Posts and Telegraphs, that after the 15th October the Paris-London telephone line is to be placed at the disposal of students of languages. Other international lines as erected are to be used in the same way.

Sherborne.—Mr. E. R. Dale has been exhibiting the Maquay system of lighting by primary batteries with considerable success, fitted up in a tent at the rifle camp and at the water works, Sherborne, Dorset. An instance of the extended demand for small lamps is given in the fact that one firm ordered this week over £200 worth of the Maquay bicycle lamps. Mr. Dale is, we understand, fitting up a dynamo and waterwheel in another part of the town, and is also intending to hold a local exhibition with an improved gas engine, dynamos, and electric fittings. Exhibits on commission will be included of other makers' goods.

Fire at Bournemouth Telephone Exchange.—It is not often we manage to set telephone exchanges on fire in England, but a case happened during the recent storm. About nine o'clock on Tuesday night a fire suddenly broke out in the switchroom at the Bournemouth central exchange of the Western Counties and South Wales Telephone Company. The whole apparatus became suddenly alight, and the night operator states that he had a narrow escape. He attributes the fire to the contact of the overhead electric lighting wires, caused by the boisterous wind that was prevailing. The fire was extinguished.

Grays (Essex).—The Grays Local Board have before them the question of improvement in the town lighting, and a report has been furnished by Mr. A. W. Boatman and Mr. J. Golden. The terms offered by the gas company were considered too high. The committee think it would be advisable to have the entire control of the lighting under the Local Board, and suggest that, as the Board are about to erect a pumping station for the sewage works, it might be well to erect machinery at the same time and light the town by electric light. The question was adjourned, and a copy of the report was ordered to be sent to the gas company.

Another Blackpool Tramway.—Blackpool is to have another electric tramway, if proposed plans are carried out. At the last meeting of the Blackpool Town Council a letter was received from Mr. C. Chadwell, engineer, of Blackburn, enclosing plans showing the route of the proposed tramway for submission to the Highway Committee. The tramway will commence at Lytham and pass through St. Anne's to Blackpool. The cars will be worked by electricity or the cable system. It is intended to apply for a provisional order next session to construct and equip the tramway, and the Council are asked to assist by assenting to the Bill for obtaining the powers.

Sunderland.—At a special meeting of the Electric Lighting Committee of the Sunderland Corporation, held last Friday, the returns were presented from some eight or ten towns in which provisional orders had been obtained for electric lighting, and some of which had been in negotiation with private companies to take over the supply. None of them, however, had come to any definite arrangement.

sides, for the addition in the time has been 1,459. Another feature not by any means enterining is that the company owes £58,243—viz.:

Debenture interest	£2,330
Loans	4,785
Creditors	24,196
Bills	26,939
	£58,250

nd it has to meet this £56,327—viz.:

Debtors	£41,075
Bills	2,845
Cash	12,407
	£56,327

That is, these balances show £1,923 to the bad, nd yet a dividend is going to be paid. No doubt he dividend will be paid not out of funds in hand, ut by increasing the indebtedness of the company, nless cash can be obtained by getting rid of some f the stock. Another item will assist to show how his precious balance-sheet has been made out. The ncome tax is *estimated* at £150. How it can be stimated at that amount when the balance-sheet hows a net profit of £17,754 passes comprehension, nd the income tax will be collected on much more han £17,754. No doubt we shall be told that this s a model balance-sheet, and that the fault is not with it but in our lack of intelligence. Perhaps it is, but as yet this is not proven. How many shareholders were induced to invest because of the profit of £21,711, which, no doubt, they thought would be available for dividend? Possibly that £21,711 has also gone into stock-in-trade. Flourishing businesses have an unaccountable way of accumulating stock, but this accumulation is unique. It covereth a multitude of sins. And the best of it is no one can discover them. Okonite has not as yet wended its way into the hearts of English users, and verily it must take heart of grace, and produce something better in the way of balance-sheets before its shares will become a palatable commodity to ordinary investors.

THE POSTMASTER-GENERAL'S REPORT.

The thirty-seventh report of the Postmaster-General has been issued. It consists of the usual statistics, showing moderate progress in telegraphic and telephonic operations, with which only we have to deal. During the course of the year, 239 post offices and 36 railway offices have been opened for telegraphic business, bringing the number of such offices to 5,912 and 1,715 respectively. The revenue from ordinary inland messages has increased by £90,125, from Press messages by £18,520, and from foreign messages by £14,822, making a total increase of £106,799. The average value of the inland message has decreased, being now 7·87d. as against 7·95d. last year. When the interest on capital expenditure is taken into consideration, there is still a deficit of £198,181 in this department. Credit is taken in the report for the successful completion of the telephone line between London and Paris. It is pointed out that great trouble was taken in selecting the land route on this side so as to avoid the necessity of putting wires underground, and we are officially informed "that conversations by telephone can now be most satisfactorily maintained between the two capitals." The rate of telegraphic working is constantly increasing. In 1870 it was by Wheatstone's instruments at the rate of 60 or 70 words a minute; now in practical working it has reached about 400 words a minute, and under experimental conditions has reached 600 words a minute. The total number of telegrams forwarded from the offices in Great Britain reaches the enormous number of 66,409,211, being an increase of 4,005,812 over the number in the previous year. What this grand total would reach to if the great local competition with telephones did not operate, it is difficult to estimate; but of this we may be certain, that the income would suffice to pay interest on capital. The net revenue—that is, the difference between total telegraph revenue and the working expenses charged to the telegraph vote—reaches £150,335, an increase of £4,541 over the net revenue of 1890, which was £145,794. If, however, the total expenditure in relation to telegraphs is taken into account—that is, the total cost of the telegraph service—the balance is altogether on the wrong side. This expenditure is £2,355,719. It should be noticed that the manufacture and issue of the stamps used, the stationery, buildings, auditing, rates, etc., are not charged to the telegraph vote, and these bring up the total cost from £2,266,356 charged to the vote to £2,355,719. In all business concerns it is best to know the exact state of affairs, and we think the national business should show its exact cost and exact returns. As the statistics are at present given this is somewhat difficult.

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard.'

THE PROFESSION OF ELECTRICAL ENGINEERING.

SIR,—The article on "The Profession of Electrical Engineering," by Mr. H. Cuthbert Hall, which appeared in your last issue, is calculated to seriously mislead those who contemplate qualifying themselves for the profession. Though perhaps the *three alternatives* given by Mr. Hall will lead some of your readers to suspect that the experience he has of the subject on which he writes must have been gained in the sister isle, and does not necessarily apply to the rest of the United Kingdom or to the Continent.

The three "alternative" methods of training suggested by the author are (1) a university course followed by an apprenticeship to a firm of electrical engineers, (2) an apprenticeship to a firm of electical engineers only, (3) a one, two, or three years' course at a technical training college.

"Of these three courses, the former is undoubtedly the best," says Mr. Hall, and, while deploring the lowness of the wage, quotes, presumably in support of his conclusions, the case of a gentleman who, after spending £800 on his education at Cambridge, where he came out fifth wrangler, and a further sum of £300 with a firm of engineers, is now in receipt of a salary of £100 per annum as the outcome of his six years' training. Assuming Mr. Hall to be perfectly sincere in the advice he gives, and that he really believes an electrical engineer must devote six years of his life and spend £1,000 for his training in order that an income of £100 t only among the members of the Board in England, but tween them and the Management Committee, who are also irectors, in America. The hopes which I have expressed are animously entertained by both sections of the Board. Our siness in Manchester, and the business in America, which has therto been successful, combined, will, I hope, enable us to ake the Company one of the first connected with the manufacture electrical wire. If any shareholder desires to ask any question will endeavour to answer it.

Sir Alexander Armstrong, K.C.B., F.R.S., seconded the otion.

Mr. Squire called attention to the amount of stock-in-trade, hich showed, he said, that they had paid £195,545 for goodwill, hich seemed to him a very large sum. He would like to now whether the legal gentlemen connected with the Company hen it was agreed to purchase the £21,711 profits that had been arned from January to June, 1890, did not know that that was oney that could not be divided among the shareholders as ividend? It ought not to have been put in the prospectus as istributable dividend. On the Dr. side of the balance-sheet he aw loans, sundry creditors, etc., £56,250. That was a large mount for a Company supposed to have a large capital of nearly 400,000, to be taking credit for. If they went into the market ith ready money they could get things cheaper. It seemed to im that they had paid too much for their goodwill, and had ought obsolete plant.

The **Chairman**, interrupting, said that none of the plant was bsolete. The new plant they had put up had been entirely for he construction of their speciality in okonite wire. So far as he knew, not a single machine had been discarded as obsolete.

Mr. Squire accepted the correction, but would like an answer s to the profits and the loans and sundry creditors.

Mr. Peters thought, considering that the Board were dealing with a capital of some £400,000, they might have given the shareholders a trading account. They had jumbled up altogether "by profits on American business £47,862," and then lower down "by purchase of properties and businesses in America and Manchester £324,990," less certain deductions. He thought they ought to be able to form a correct opinion as to whether the expenses chargeable to trading account bore a fair proportion to the profit earned. He would like to know how much out of that net sum which represented the great asset of £218,979, was really represented by *bona fide* goodwill and nothing more? When they paid the interim dividend up to December, 1890, amounting to £10,694, the Directors told them they had every reason in justification of that payment. Everything looked fair and right, which no doubt was the case. But considering that that payment only left £7,059 altogether, he would scarcely have supposed that any Board would have paid a dividend right up to the hilt. For this reason it appeared to him that they had made no profit at all for the last six months.

In replying, the **Chairman** said that as regarded the profits derived from trading, the Directors did not think it would be advisable to make a statement public, because it might be made available for the purposes of their rivals and customers. That was the only reason why they and other large companies (Armstrong's, for instance) did not publish the details of their trading. But if any shareholder wanted information, their managing director (Mr. Stevens) would be very happy to give it him. As to Mr. Squire's questions, only those profits could be divided which had been made during the existence of the Company, and the purchase of the indivisible profits (£21,711) must of necessity be the purchase of an asset which could not be divided as dividend among the shareholders. He could only say that the purchase of 21,711 sovereigns for £21,711, though not particularly profitable, was fairly satisfactory. The real reason why these profits got to such a pitch was the delay in the registration of the Company. The purchase of the American business was fixed for January, 1890, but owing to circumstances the registration of the Company could not take place until June. In the interval, the profits to which they were entitled under the contract as from January 1st swelled to the amount mentioned.

A **Shareholder** pointed out that he became one under the idea that these profits were divisible, and he wanted his share of them. Other shareholders concurred.

The **Chairman** said he had no doubt that if a prospectus was presented to a layman with a statement in it of profits earned before the registration of the Company, he would look upon them as divisible. The legal mind would not have so regarded it. He freely admitted that every shareholder was entitled to grumble. But they must admit that they got their share of them, not in their pockets, but in the ultimate benefit they would derive by reason of the reduction of the capital, the amount being appropriated to that purpose. As to another question, the amount which was appropriated to goodwill was very easily ascertainable from the prospectus, because the valuation of real estate was given there in full, and the amount given for the goodwill was, in fact, the difference between the valuation of the real and other estate, and the amount of the purchase-money. He believed the amounts for goodwill would work out to £11,000 for the Manchester business, and £80,000 for the American, or £91,000 out of £218,000 might be taken as representing goodwill, processes, patents, and other matters of that kind.

In answer to another shareholder, the **Chairman** said that the Manchester works were now in full working order. Their okonite samples were now before customers, and they expected to have orders almost immediately. The capital expenditure had been completed. They had commenced working within the past fortnight. They were endeavouring to introduce okonite wire into all possible forms of consumption, but it was right that he should say that as yet the cable companies' electricians preferred guttapercha-covered wire to any other form of insulation for submarine cables.

Shareholders having expressed a wish to hear Mr. Stevens, managing director, the Chairman then called on that gentleman. He said he did not wish to go into details, but would be pleased to give information as to the prospects of the business to any shareholder if he would call at the office. They were closely watched, and were in competition with firms of great standing and considerable wealth, and any information given publicly was likely to be used to their disadvantage if it concerned details as to prices and profits. They were not relying solely upon any one branch of their business. Their managers and employés at the Manchester works were skilled men, who were thoroughly acquainted with their business. For years Messrs. Shaw and Connolly had been carrying on an indiarubber insulated wire business. To that they had added the okonite business and that of making guttapercha and compound covered wires. The compound was made of paper or cotton, or some form of dielectric of that sort insulated with oil. They had also laid down, in America and England, a most extensive lead-covering plant which was likely to lead to large orders. They were now on the list of contractors to the Admiralty, which was a very important consideration, and this would be followed by their being on the War Office list also. It was important, because before they could get on that list their works were examined by a Government inspector, as the Government would not allow them to contract unless they were in a position to do so. There were only three contractors on the list at present, and they meant to get into that close corporation and obtain their proportion of orders. This business would of itself pay a very respectable dividend on the capital employed in their English business. Railway companies were very conservative, and did not care about moving until they were well satisfied. They had submitted samples to some companies, and had small orders, satisfaction being expressed with the goods. They had supplied one or two very large installations, and would in a short time be able to get their full share of work—a share to which they were entitled as being, with the exception of one company, the most powerful company in England, and having the most complete works. In America, they were far and away first. He had been to America twice since the Company took over the American business. He found it most admirably managed, but by people who had taught themselves in a great measure. They were expert electricians, but had not had the experience which came from long handling of such a material as rubber. Mr. Connolly went over there, and looked after the technical part of the business. He learned their okonite business and taught them processes which would be of use to them. He (the speaker) looked into the business part, and several alterations necessary to fit in with English ideas had been carried out. The accountants to the Company, who had a branch in New York, sent over monthly balance-sheets which afforded a perfect check. As to the progress made in England, he thought it was highly satisfactory. Month by month the sales were increasing. During the time they had been manufacturing in Manchester, they had had to build up their factory through a very bad winter which had interfered with the operations. They had also had to manufacture their own machines, because they would not let them be made outside. They bought castings all over the country, and put them together themselves. During this time they had had to keep moving their machinery about in order to execute orders, but now they were completely equipped.

Mr. Shaw, one of the Manchester managers, also spoke, and dwelt on the bad times the electrical industry had gone through. Since June, however, they had been steadily increasing their turnover. September was 30 per cent. better than the same month in 1890, and October was better still. The moment he was able to place okonite manufactures they would be doing a very big business indeed. His customers were applying for them, and he thought there was a good prospect before the Company during the next twelve months.

The **Chairman**, after some remarks as to the good to be derived from holding a friendly conference with shareholders, put the resolution adopting the report and accounts, and it was carried unanimously, as also was a resolution confirming the declaration of a dividend at the rate of 8 per cent. per annum upon the preference shares, and the application of the balance of £259. 7s. 2d. to the reduction of preliminary expenses. The Chairman remarked that the dividend would be paid in a week or ten days.

The auditors, Messrs. Price, Waterhouse, and Co., having been elected, a vote of thanks to the Chairman was passed, and the proceedings closed.

COMPANIES' REPORTS.

EASTERN EXTENSION TELEGRAPH COMPANY.

The Directors, in their report for the half-year ended June 30, state that the gross receipts, including Government subsidies, amounted to £264,878, against £254,856 in the corresponding period of last year. The working expenses, including £17,318 for cost of repairs to cables and expenses of ships, absorb £71,746, against £76,670. Deducting income tax, interest on debentures, debenture stock, and contributions to sinking fund, and £2,179 for special expenditure, there is £155,165 available. One quarterly interim dividend of $1\frac{1}{4}$ per cent. was paid during the half-year, and another of like amount will be distributed on the 15th inst.,

NOTES.

Dundee Tramways.—The burgh engineer of Dundee has been instructed to prepare a scheme for the extension of the tramways.

Kimberley.—Arrangements are being made, we learn, for holding a universal exhibition at Kimberley, Cape Colony, during September, 1892.

Institution Dinner.—The third annual dinner of the Institution of Electrical Engineers will be held at the Criterion Restaurant, Piccadilly, on Friday, Nov. 13.

Derry.—We learn that the spirited enterprise of Carlow and Larne have caused the authorities of Derry to decide upon having the electric light for the coming season.

Liverpool Electrical Laboratory.—The electrical laboratory of the Liverpool School of Science is so well attended that it has been necessary to open it on Thursday as well as on Friday evenings.

Bilston.—On the recommendation of the General Purposes Committee, the Bilston Township Commissioners at their meeting last week accepted the tender of the Brush Electrical Company for lighting the Market Hall by electricity.

Brussels-Amsterdam Telephone. — A despatch from Brussels states that at the beginning of next year telephonic communication will be opened between that city and Amsterdam. The line will pass through Antwerp and Rotterdam, where telephone stations will also be established.

Aberdeen.—The electric lighting scheme seems to be in an undecided state in Aberdeen. It will be remembered that a project was brought forward by Mr. Liardet for the use of water power. This has not been as yet accepted, and no definite proposal has been laid before their consulting engineer.

Rotary Currents.—Messrs. Siemens and Halske, before the close of the Frankfort Exhibition, installed a rotary-current motor, having an armature of the usual Gramme type with three brushes on the commutator. The speed can be varied within wide limits, and it is intended to use this motor for tramway work.

Mansion Lighting.—Messrs. Drake and Gorham have just completed and successfully started up another private house, which has been lit on the special system which they employ for work of this kind. Shendish, near Hemel Hempstead, has been lit for Mr. A. Longman. The installation consists of about 100 lights.

Eastbourne.—At the meeting of the Eastbourne Town Council last week, the proposal to connect the pavilion with the Corporation electric lighting system was raised, Councillor Blaker asking why the lamps at present in use could not be utilised for the new system. It was stated that they would not stand the test of the high-pressure system.

Mansion Lighting.—A complete electric lighting installation is being erected at the Mansion, Doublebois, Cornwall, under the superintendence of Messrs. Morgan Williams and King, consulting electrical engineers, Victoria-street, Westminster, the prime motive power being derived from a petroleum engine. Mr. F. M. Newton, of Taunton, is the contractor.

Huddersfield.—At the meeting of the Huddersfield Town Council on Wednesday, it was decided to make application to the Local Government Board for power to borrow £50,000 for electric lighting purposes, but before absolutely borrowing the money the Gas Committee should see what the Finance Committee could do in the way of finding the money.

Leamington.—When the letter from the Aurora Electric Lighting Company was read at the Leamington Town Council meeting, Councillor Crowther suggested a reply should be sent, "Once bitten, twice shy." Councillor Bright said the Aurora Company offered to supply current at about half that which they were before paying. The town clerk was instructed simply to acknowledge the letter.

Electric Carriage.—M. Malignani, director of the electric station of Udine, France, has built himself an electric carriage with a battery of special construction, and a motor geared to the axle. The carriage travels at eight or 10 miles an hour, and the cost is given (without details) as 1d. per car mile for a six-hour run. The car takes three persons, and M. Malignani is intending to further develop his ideas to tramways.

Koechlin Electric Meter.—The meter invented by Maurice Koechlin, of Belfort, France, consists of a Wheatstone bridge arrangement, one branch of which includes the circuit to be measured, and another branch includes a variable resistance, the latter furnished with an electric motor device, whereby, if equilibrium be disturbed, the movement both balances the two resistances and registers the movement at the same time.

Yarmouth.—Only 200 applications for electric light having been received in answer to the advertisement by the Town Council, the surveyor does not consider such a meagre response warrants the Council in providing an installation. He suggested further attempts by private circular if desired, but the Council decided not to take further steps in the matter until they had visited other towns lighted by electric light.

Berlin.—A report of the Berlin Electrical Works shows that from the 30th June, 1890, to the 1st July, 1891, there was a large increase in the number of consumers—namely, from 872 to 1,314, being about 50 per cent.; the sale of lamps has increased from 74,959 to 104,100. Orders for an additional 25,000 to 30,000 normal lamps have been secured for next winter. Electricity is also much used for business purposes, the company having largely reduced their tariff.

Cost of Electricity.—M. Haubtmann, in a communication to the Société des Ingenieurs Civils, makes some comparisons between the cost of electricity in various towns. He gives the cost of the electrical horse-power in London as 3·75d., three times that of gas; in Paris it is 9d.; at Saint Brienc ·52d. Fribourg, in Switzerland, has the honour of being the cheapest place for electric power in Europe: here it is 1½d. per electrical horse-power, falling to 1d. only for those taking over 20 h.p.

Sewers in St. James's.—A correspondent signing himself "Piccadilly" wrote to the *Times* on Monday complaining of the sewers in St. James's, attributing the fault to the electric light company forcing waste steam into the sewers. To this ridiculous complaint the managers of the St. James's and Pall Mall Company simply wrote stating that the company does not, either at its station or elsewhere, force waste steam into the sewers, but discharges it from a chimney shaft at the height of 130ft. above the ground.

Glasgow.—The long-desired conference between Sir William Thomson and the Electric Lighting Committee of the Glasgow Corporation has recently been held, and a general understanding has been arrived at that for the compulsory area of the provisional order the low-tension continuous-current system shall be adopted. For other districts where a demand for electric light may arise, it is ing inserted, so that when the globe, G, is put into place d the cage, C, screwed hard up, the whole fitting is roughly watertight.

Fig. 9 is a roof light.

Figs. 10 and 11 show a section of a sconce and a comete view. The connection is made by the three spring ngers, S P. The front has a hinge on the right side and a screw on the left. W R is a white enamel, or mirror, reflector, round the edge of which a rubber washer, R W, of square section is placed in a suitable groove. When the lamp has been fixed and the front is closed, the shoulder on it, S, bears on the rubber washer, and when the screw, *s*, is entered and screwed up tight no water can possibly get in.

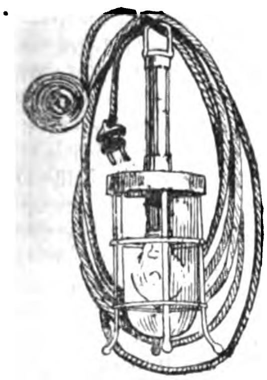

Fig. 12.—Hand Lamp.

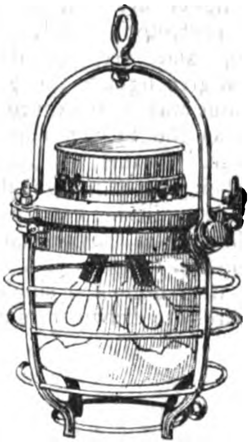

Fig. 13.—Gangway Lamp.

Figs. 12 and 13 are hand lamps and gangway lamps, and Fig. 14 is a section of a cargo reflector. It consists of a metal shade, to which the brass bowl reflector is attached, the whole, together with the stock, forming part of the return. Inside is a metal rim, insulated from the shade, and from this an insulated wire is led to the centre contact in the gooseneck. Round the bowl, holes are bored and tapped to receive the lampholders, being so placed that when the latter are screwed home their contacts bear on the insulated rim. The fixing of the holders is thus rendered very simple, and a great deal of time is saved.

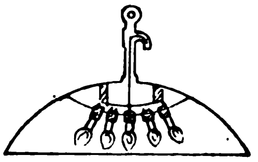

Fig. 14.—Cargo Reflector.

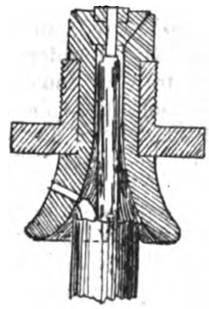

Fig. 15.—Concentric Swivel.

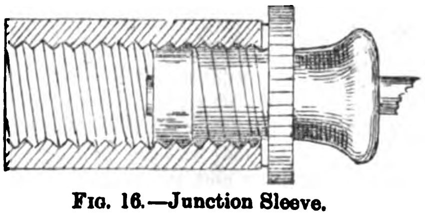

Fig. 16.—Junction Sleeve.

The flexible lead may be either twin wire or concentric wire. To each end of it a concentric swivel is soldered as shown in Fig. 15, and by screwing this into the gooseneck, and into a junction-box provided for the purpose, connection can be made in a few moments. By means of brass sleeves Fig. 16, any number of these leads can be joined into one, which in many cases will be found very convenient. This concludes the fittings which may be considered necessities. Others may be added, or those mentioned may be made more ornamental according to the fancy of the owner.

In conclusion, I may say that people are sometimes inclined to expect an electric light installation to look after itself. This is expecting too much, and no installation, no matter how well it is designed and carried out, will give satisfaction if it is not properly looked after.

BRITISH ASSOCIATION CARDIFF MEETING.

JOINT DISCUSSION ON UNITS BY SECTIONS A AND G.

Dr. Oliver Lodge: There are a good many things to be said about units at the present time, both mechanical and electrical. I think it will be for the convenience of the section if at the beginning of the discussion we attend principally to the electrical units, and to those units which are of established interest to engineers, and leave the more academical and mechanical units to a later period. With regard to electrical units, one of the most pressing things is the determination of an authoritative statement or agreement as to the coefficient of induction—not only self-induction, but also mutual induction. Now, we know that already a great many names have been suggested for this unit. The mere name of the unit is, of course, very unimportant from some points of view, but it is not wholly unimportant whether this unit shall be called secohm or quadrant, or by the name of some man. Henry, mac, and other names have been suggested. The name secohm has certain advantages, in that it indicates the relation between this unit and the ohm-second, but there are certain disadvantages in that it tends to express the more simple by the more complicated. It expresses the unit self-inductance as being derived from the ohm, whereas the determination of the ohm itself is based upon a measurement of inductance; instead of describing the self-inductance unit as an ohm multiplied by a second, it would be more logical to call the unit of resistance a self-inductance divided by time. In all methods of determining the ohm, some form of coefficient of induction is the length that enters into the expression. If it is to be called a quadrant, it must be remembered that a quadrant is strictly an angular measure; and even though it be understood as short for earth-quadrant, and therefore a length, still it is not unobjectionable, for it is pretending a thing to be a length when it really is not a length. I think it would be a backward step if we fix it for all time as a length. On the whole I should suppose that some name of less obvious meaning might be desirable, such as the name of a man. Now directly we permit ourselves to regard the name of a man as a possible name to be attached to the unit, we have the field open to consider. We are no longer compelled to make it equal to a secohm: it may be a sub-multiple. Now let us consider whether the secohm is a convenient size. The C.G.S. units were a connected system, or might have been a connected system, before any practical units were invented. Practical units were invented for this reason, that C.G.S. units were not a reasonable size—they were a million times too big or too small. It was out of the question for engineers to be always speaking of powers of ten. Now a secohm is rather big for a practical unit. Very few people —I speak under correction—have to deal with coefficients of induction of more than a secohm. The question is whether it would not be better, therefore, to make our practical unit some sub-multiple, say a thousandth, or something of that sort. We have a consistent system in the C.G.S.; there does not seem adequate need for two consistent systems. I regard it as more important to have the practical units of convenient size, than to have them most simply related among themselves. The farad has been useless, by reason of the neglect of this idea. The whole object of a practical system is to have units of convenient size, otherwise the C.G.S. would be all that is necessary.

The next unit wanted is a practical unit of magnetic field, or the unit of magnetic induction. Let me just explain what I mean by a practical unit of magnetic field. There is a C.G.S. unit—and it has not at present had a name given

ad to an installation has had to be abandoned,
the opportunity came at last, and the line is
pped. It is unnecessary to enter into the history
e Roundhay tramway, but we may say that it
ed a much better opportunity for electric traction
almost any other line in the kingdom. We
often pointed out that many different conditions
e States have lead to the introduction of electric
tion. Here mileage is almost at a standstill,
e it is rapidly increasing. It is the new lines in
erica that patronise electricity to the greatest
nt. Here the permanent way *is* laid, the initial
tal spent, and the only question for the manage-
t is to earn dividends. To change the system
working means, in most instances, increasing
capital to carry out the necessary alterations.
are therefore in this position: Most tramways
under existing conditions, earning a fair divi-
d; they are promised a *probable* increase, if they
l change their system; but, on the whole, they
, "A bird in the hand is worth two in the bush."
are quite sure that electric traction is the best
ans of working our tramlines; but who will
vide us with an argument to combat the "bird-
the-hand" view? Prominent tramway men have
in and again said to exploiters of electrical systems
o have urged the adoption of their pet system,
es, what you say is all very well, and here is
r offer. You say the cost of working your system
so-and-so. We will hand you over our lines to
rk, providing you will pay us such and such a
te. According to your own showing that will
ave you handsome profits." In other words, the
anagers cynically say, "Have the courage of your
nvictions." There are one or two cases on record
here this courage has led to a contract; but as yet
body outside the inner management of the con-
actors knows the true state of the balance-sheet.
hat they can see, however, is that the con-
actors are in no hurry to increase their con-
acts. The Roundhay tramway differed widely
om these dividend-earning tramlines. There
ere the lines, but they were unused. There was
o man in possession, so there was no existing equip-
ent to put aside. Hence the advantage to elec-
ical enterprise, and electrical enterprise has taken
old—with what result the future must say.

THE LONDON ELECTRIC.

The various rumours concerning the London
lectric Company are in most cases the outcome of
n excited imagination. Fortunately, or unfortu-
ately, a very large proportion of the public has
btained the impression that the London Electric is
he sole company supplying a large area of the
etropolis, and every *canard* about the electric light
s laid to the London Electric. If a light goes out,
r if a street is up, murmurs resound against this
ompany. It has been our special object at various
times to trace the correctness of these rumours, and
having recently heard of stoppages, resolved to get
at the truth of the matter. Enquiry at the
fountain head results in our being able to state authoritatively that the number of stoppages has been three—one of four minutes, one lasting two minutes, and one lasting ten seconds. It is unnecessary to expatiate at length upon the mountain made in some quarters out of this mole-hill, which is not more than has happened to competitors during the same time.

To come to more important matters, the company is now supplying current for 37,243 lamps. This total is rapidly being added to, and in a short time—in fact, as soon as they can be connected—will reach 40,000 lamps. The machinery at Deptford is now capable, without addition, of supplying 90,000 lamps. The current is now regularly supplied during 22 hours a day, and from November 1st the supply will be continuous. For the moment the most important fact about the London Electric is that they actually and without difficulty supply current from Deptford generated at a pressure of 10,000 volts, a pressure unheard of in any other similar installation. Whether the system of generating at a distance, transmitting at a high pressure, and distributing by means of transformers, will be commercially successful is the question now under trial. The electrical engineer has solved one part of the problem—he can do his part of the work. It cannot be expected that a station laid out for, say, a quarter of million of lamps, will become a paying concern within a few months of its commencing operations. The company will now push ahead and strain every nerve to get the 90,000 lamps on; then it will consider exactly what it will do as regards continuing operations on the exact lines now laid down, or whether experience will dictate some modification. At any rate we ask electrical engineers to be less ready and less eager to believe everything that is said about any of the central station operations. There is one infallible test, only supplied by time in a series of annual balance-sheets. Wait for these before crying "spilt milk."

WHAT IS ELECTRICITY?

Most writers answer this question by candidly admitting their ignorance. Not so, however, a writer in *Science Siftings*—a new paper that is to educate the multitude. We have been violently assaulted—metaphorically—by unbelievers because of our cocksuredness upon certain questions, but we must bow before the new prophet. Some of our readers, in New Zealand or Australia, or some other benighted corner of the earth's surface, may not have the advantage of seeing the first number of this new paper, and we are thus enabled to enlighten them upon so important a topic. Well, but what is electricity? That is the question. Our contemporary promptly proceeds to riddle out three kinds for us. The result obtained is consoling, and accounts for many vagaries of expression with writers and speakers. In future, when attacked on account of ignorance, it is easy to reply, Oh! you are talking about one kind of electricity, I

NOTES.

Durban is to be lighted by electric light on the Thomson-Houston system.

Edison's Patents.—In a recent interview, Edison says he has never made anything out of his European patents.

Institution Dinner.—The annual dinner of the Institution of Electrical Engineers takes place to-night at the Criterion Restaurant at 7 p.m.

Lubrication.—We have received a neat pamphlet on "Lubrication—Oil to Save Power" from the Vacuum Oil Company, The Albany, Liverpool.

Spanish Technical Review.—We are in receipt of the *Revista Tecnologico Industrial*, the monthly publication of the Association of Industrial Engineers of Barcelona.

Electric Printing.—The presses upon which the *Western Electrician* is printed are now run by electricity. A 25-h.p. Edison electric motor is used, current being supplied from the Chicago Edison Company.

New Business.—We hear that Mr. George North has resigned his appointment with Woodhouse and Rawson United, Limited, in order to commence business on his own account at 90, Queen-street, E.C.

Paddington.—The Paddington Vestry has decided to accept the offer of the Metropolitan Electric Light Company to supply all buildings in Paddington with electric energy at 7d. per Board of Trade unit.

Ferranti Mains.—The firm alluded to last week as putting down plant to manufacture Ferranti mains is the British Insulated Wire Company, Prescot, Lancashire, who have purchased rights for manufacture and sale.

Cork Asylum.—At the meeting of the directors of the Cork District Lunatic Asylum, the estimate of an English firm for lighting the new building by electricity was read, but on account of expense it was decided to use gas.

Persia.—It is stated that a syndicate of Belgian financiers have obtained a concession from the Persian Government of the monopoly of electric lighting in Persia. The office of the company will probably be at Brussels.

Society of Arts.—The first ordinary meeting of the Society of Arts will take place on Wednesday, 18th inst., at 8 p.m., when the opening address will be delivered by the Attorney-General (Sir Richard Webster, M.P.), chairman of the council.

Electric Railways.—Edison considers three stationary generating engines of 10,000 h.p. each will be required to run the whole of the Pennsylvania railroad system as projected. Mr. Villard will soon have a track for demonstration ready near New York.

Pullman Electric Cars.—The Pullman Palace Car Company have recently built an immense and palatial double-deck electric car, driven by two 25-h.p. Westinghouse single-reduction motors. The West End Railway, of Boston, has ordered four of these cars.

Explosion at Hastings.—Trouble was experienced at Hastings by an explosion supposed to be caused by leaky gas collecting in the junction-boxes of the underground mains. The fuse went, and the lamps on the sea front were extinguished temporarily, but no personal damage was done.

Partick (N.B.).—At the meeting of the Partick Town Commissioners on Monday a letter was read from Mr. Cook, electrical engineer, recommending the Commissioners to apply to the Board of Trade for a provisional order for electric lighting, and the matter was referred to a committee for consideration.

Mutual Telephone Company, Limited.—Seven hundred and fifty subscribers to this company's Manchester exchange are now connected. The company has 38 private wires also completed. On October 31 they possessed in Manchester 154 standards, 76 poles, 190 cables, 209 distributing-boxes, 1,050 miles of wire, and attachments to 720 buildings.

Telephoning between Lincoln and Liverpool.—The telephonic communication was established on Thursday last week between Lincoln and Liverpool. The Mayor of Lincoln spoke through to the Mayor of Liverpool, and offered him his congratulations on the success of the enterprise. The congratulations were mutual, and each voice could be distinctly heard.

New French Electrical Review.—Another technical electrical journal is stated to be in contemplation in Paris, the *Revue de l'Electricité*. France is well off for electrical journals; although gas has only five, the science and practice of electricity has already eight technical papers, and the above will make a ninth—a striking comment on the activity of electrical science.

The Electricity Act in Burmah.—It is officially notified, says the *Indian Engineer*, that in exercise of the power conferred by Section 5 of the Scheduled Districts Act, and with the previous sanction of the Governor-General in Council, the Chief Commissioner of Burmah is pleased to extend the Electricity Act (XIII. of 1887) to Upper Burmah, except the Shan States.

Deptford.—We are sorry, though perhaps not altogether surprised, to hear that a serious breakdown has taken place in the mechanical arrangements of the Deptford central station. We can only think that it is an extreme pity that the directors and Mr. Ferranti have thought well to entirely sever their connection until the station was more in thorough working condition.

Huddersfield.—The Corporation of Huddersfield are about to erect an electric lighting station and plant, and to lay mains in connection therewith, and are prepared to receive applications from electrical engineers competent and willing to superintend the execution of the works, the contractors for which are the Brush Electrical Engineering Company, Limited. Particulars of application may be seen in the advertisement columns.

Hammersmith.—The Hammersmith Vestry has decided to refer to their Electric Lighting Committee the question of electric lighting in the district. The committee will consider the draft provisional order and map of the proposed area of supply by the Putney and Hammersmith Electric Light and Power Supply Company, and a special meeting of the Vestry will be held on December 9th to consider the report of this committee.

Royal Meteorological Society.—At the meeting of this society to be held at 25, Great George-street, Westminster, on Wednesday, the 18th inst., at 7 p.m., the following papers will be read: "Report on the International Meteorological Conference at Munich, September, 1891," by Robert H. Scott, M.A., F.R.S.; "Results of Meteorological Observations made at Akassa, Niger Territories, May, 1889, to December, 1890," by Frank Russell, F.R.M.S.

Liverpool.—The second largest installation of electric lighting in Liverpool has been put in University House,

UNDERGROUND MAINS.—X.

THE ST. PANCRAS MAINS.

The underground electric light mains used in the central station of the St. Pancras Vestry are laid upon the three-wire system of bare copper strip upon earthenware insulators in culverts, according to very careful designs prepared by Prof. Henry Robinson, C.E., consulting engineer to the Vestry. The mains are constructed so far as regards the insulators and conductors by Messrs. Latimer Clark, Muirhead, and Co., Regency-street, Westminster, the concrete culverts being laid by Messrs. Mowlem and Co.

The whole of the details for these mains have been carefully carried out to drawings and laid under the personal supervision of Prof. Robinson and his assistants, together with Mr. Thornton, manager to Messrs. Clark, Muirhead, and Co., and his assistants, and embody a very thorough and efficient distributing system, great care having been taken to adjust the size of mains to the probable demand, and to provide for efficient draining and the prevention of electrical leakage by reason of damp.

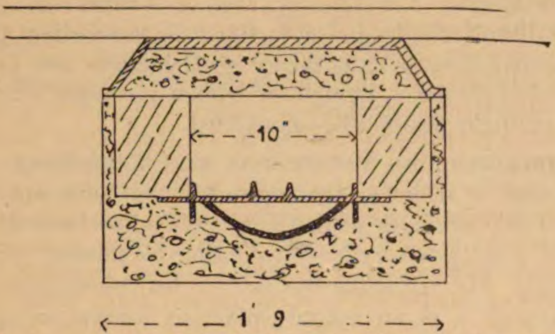

Fig. 1.—10in. Conduit, for One Set Underground Mains.

In principle the St. Pancras mains consist of bare strips of copper carried edgewise upon earthenware insulators of special shape, these insulators being themselves supported and kept in place by being slipped upon studs which project from cast-iron cross-bars or brackets, built in at intervals along brick and concrete culverts. This is the kind of main mostly used, but in practice it is found necessary to employ both a culvert system and a pipe system, the latter being used when room is scarce. In this case the mains are made up of the same copper strips and earthenware insulators tightly bound together, and drawn in solid as a complete set of mains into iron pipes.

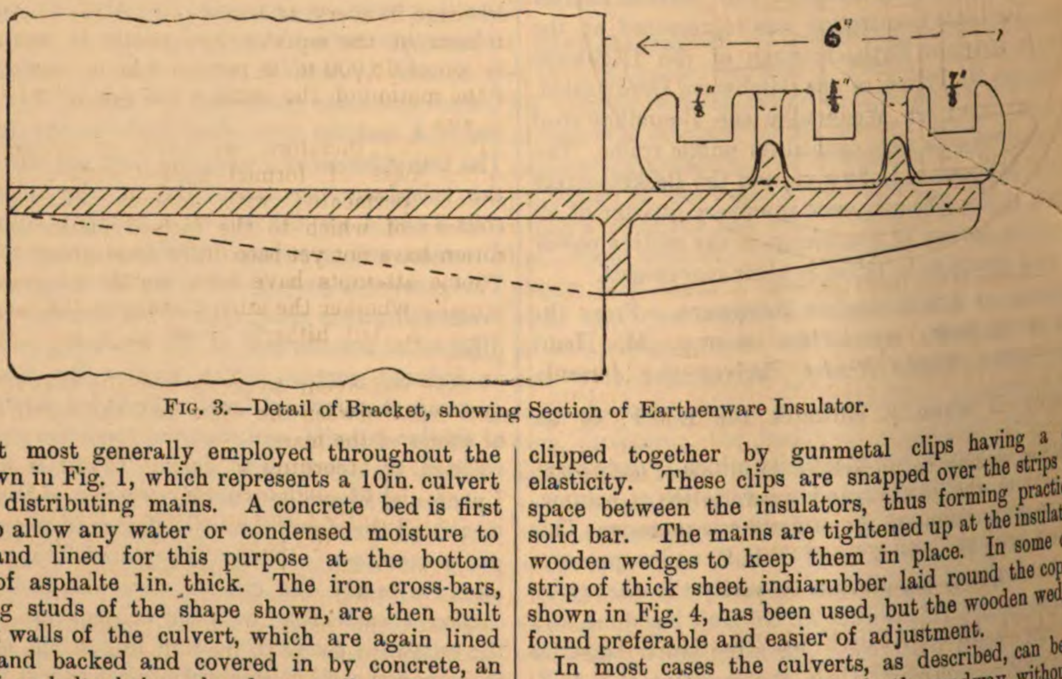

Fig. 3.—Detail of Bracket, showing Section of Earthenware Insulator.

The culvert most generally employed throughout the district is shown in Fig. 1, which represents a 10in. culvert for one set of distributing mains. A concrete bed is first laid, sloped to allow any water or condensed moisture to drain away and lined for this purpose at the bottom with a layer of asphalte 1in. thick. The iron cross-bars, with projecting studs of the shape shown, are then built into the brick walls of the culvert, which are again lined with cement and backed and covered in by concrete, an upper layer of asphalte being placed over all as finish to prevent moisture percolating through. This culvert is used when laid under the pavement, and the flagstones come down upon the roof of the culvert.

A larger culvert, as used under roadways, is shown Fig. 2. This is an 18in. culvert for two sets of mains by side, or one set each of mains and feeders; and in cases a third set is also run above the others upon brackets having similar projecting studs, built into the wall shown. The detail of this bracket and also of the earthenware insulators is shown in Fig. 3. Each insulator has three rectangular grooves to receive the three sets of copper strips, and is also pierced from below by two taper holes which fit upon the projecting studs of the iron brackets cross-bars, the weight of the mains being amply sufficient to keep the whole in place. The culvert is constructed, before described, of brick and concrete with an upper layer of asphalte, the earth of the roadway coming above this. Iron pipes are laid alongside the culvert

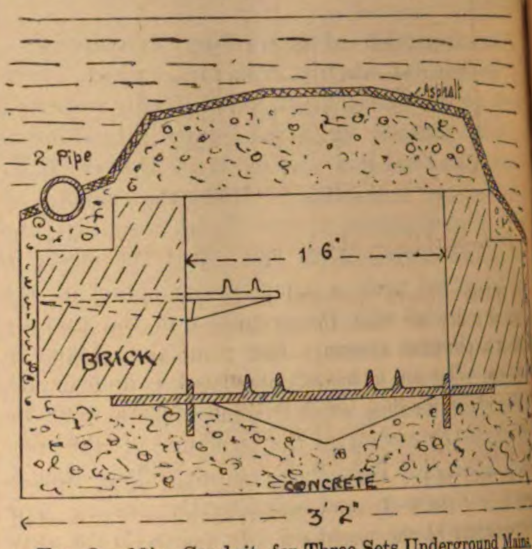

Fig. 2.—18in. Conduit, for Three Sets Underground Mains.

as shown in cases where the series arc light is to be carried out, for the reception of the high-pressure mains. Junction-boxes and drawing-in boxes are inserted in the pavement or roadway at intervals, fitted with watertight lids filled in with slabs of concrete on the upper surface, or roughened to give foothold. The culverts are always widened out at each junction-box to allow room for connecting up and handling the copper strip.

The strips of copper are joined end to end, being fully cleaned and riveted with a lap-joint, then straightened and laid or drawn in, and strained to lie straight in the slots. Each main consists of several strips, which clipped together by gunmetal clips having a elasticity. These clips are snapped over the strips space between the insulators, thus forming practi solid bar. The mains are tightened up at the insulat wooden wedges to keep them in place. In some strip of thick sheet indiarubber laid round the cop shown in Fig. 4, has been used, but the wooden wed found preferable and easier of adjustment.

In most cases the culverts, as described, can be either under the pavement or in the roadway, withou trouble in arrangement than the occasional shifting or water pipe. Whenever possible, these pipes, if across the line of culvert, are raised or lowered a

SANITARY DISTRICT.				GAS LIGHTING.								
City or Town.	Borough or local board.	Population of sanitary district.	Area of sanitary district.	Area of lighting district.	Length of streets in lighting district.	Is the gas undertaking the property of the authority?	Price of gas per 1,000 feet.	Cost of lamp burning feet per hour per annum.		Cost of gas lighting per annum, before lighting by electricity.	Area of lighting district.	Lengths of streets in lighting district.
			Acres.	Acres.	Miles.			Ft.	£ s. d.	£ s. d.	Acres.	Miles.
BACUP	B	25,033	6,400	3,500	57	No	3/7	4½	2 1 10	1,423 16 0	20	3
BARNSLEY	B	35,000	2,400	200	6	No	3/4	4	2 8 6	1,800 0 0	200	6
CAMBRIDGE	B	41,070	3,278	3,278	33	No	2/10	4½	2 17 9	2,932 17 6	3,278	33
LONDON (City)	—	—	—	—	—	—	—		—	—	—	--
BARNET	L.B.	4,095	245	245	—	—	—	—	2 18 0	—	—	—
BATH	C	51,835	3,745	3,745	50	No	2/8	4	2 12 6	5,600 0 0	Centre of city only	5
FAREHAM	L.B.	7,171	29,000	—	6½	No	3/9	4	4 0 0	500 0 0	—	6½
LEAMINGTON	B	—	—	—	—	—	2/6		—	—	Parade.	½
TAUNTON	B	20,000	1,200	—	—	No	4/- less dis.	5	2 15 0	765 0 0	—	3
WATERFORD	C	23,000	532	532	15	No	5/6 less 15 p.c.	4	3 16 0	1,612 0 0	150	4
WEYBRIDGE	—	—	—	—	—	—	—		—	—	—	6½
CHELMSFORD	B	12,000	—	—	13	No	4/-	187 burners for 3,410 hours.		—	—	1,000 yds.
EASTBOURNE	B	30,000	5,506	880	30	No	3/2	5	4 4 6	—	Parades.	1,600 yds.
GALWAY	B	19,171	4,480	—	18	No	4/9		—	400 0 0	Harbour only.	—
GREENOCK	—	—	—	—	—	—	—		—	—	—	—
NEWCASTLE	B	163,000	5,371	—	155	No	2/1 less 10 p.c.	5	2 12 0	—	5,371	155
BOURNEMOUTH	B	35,000	5,506	—	55	No	—		—	—	—	—
BRIGHTON	B	107,546	—	—	—	No	—		—	—	—	—
BRADFORD	B	240,515	10,776	—	—	Yes	2/3	4½	2 10 0	—	—	—
HASTINGS	B	42,258	—	—	—	—	—		—	—		—
CARDIFF	B	82,761	—	—	—	—	—		—	—	—	—
EXETER	C	37,665	—	—	—	—	3/-	5	3 13 0	—	—	—
EDINBURGH	C	—	—	—	—	—	—		—	—	—	—
KESWICK	L.B.	3,500	728	367	4	No	4/- lighting 3/3 cooking	—	1 13 6	—	—	—
OKEHAMPTON	B	1,695	—	—	—	—	—		—	—	—	—
SHEFFIELD	B	332,837	19,651	—	—	No	2/2		—	—	—	—
ST. AUSTELL	L.B.	4,520	—	120	4	No	5/-	5½	1 9 3	110 0 0	—	—
LIVERPOOL	C	613,463	5,210	5,210	276	No	2/8	4	2 17 11	35,410 7 8	—	—
THETFORD	B	4,520	—	1 sq. mile	—	No	5/-			180 0 0	—	—
BIRMINGHAM	C	462,000	8,420	8,420	200	Yes	2/3 to 2/7	5	1 14 5	12,000 0 0	—	—
NORWICH	B	100,000	7,000	—	—	No	—		—	—	—	—
NORTHAMPTON	B	60,000	1,520	500	30	No	3/1	5	2 5 3	—	—	—
READING	B	62,000	5,861	5,861	—	No	—		—	—	—	—
SOUTHAMPTON	B	60,051	—	—	—	—	—		—	—	—	—
DARLINGTON	B	40,000	3,909	3,909	—	Yes	2/2	5	2 15 6 Bray's 80 c.p.	2,300 0 0	—	—
FOLKESTONE	B	22,000	2,481	2,481	26	No	3/3	4	” ” 2 16 0	—	—	—
OXFORD	C	53,000	4,650	4,650	48	No	2/4 to 2/6	4	2 10 0	2,400 0 0	—	—
SWANSEA	B	96,282	5,963	—	50	No	2/10 to 3/-	4	2 16 1	—	85	4
SCARBOROUGH	B	35,500	2,292	—	35	No	2/8 to 3/3	4½	2 15 10	—	—	—
WIMBLEDON	L.B.	28,000	3,225	2,000	29	No	3/10	4	3 10 0	—	—	—

which are suitably equipped for public lighting also): Bournemouth, Brighton, Bradford, Hastings, Cardiff, Exeter, Edinburgh, Keswick, Okehampton, Sheffield, Woking, and St. Austell; and companies are commencing operations in Norwich, Northampton, Reading, Southampton, Dublin, and Glasgow. In the following towns the corporations work the system themselves: Bacup, Blackpool, Barnsley, Dublin, Greenock, Glasgow, and Bradford, and it is worked by companies in London, Barnet, Bath, Taunton, Waterford, Weybridge, Woking, Chelmsford, Eastbourne, Galway, Newcastle, Bournemouth, Hastings, Exeter, Edinburgh, Keswick, Okehampton, St. Austell, Birmingham, and Reading.

The progress the electric light has already made has conclusively demonstrated its applicability for public and private lighting, and improvements of machinery and apparatus are continually taking place, tending to enhance its efficiency and reduce the cost of production.

SYSTEMS.

The systems employed are various applications of the following:

1. Low-tension, direct-current, three-wire system.
2. High-tension, direct-current, charging accumulators in storage batteries.
3. High-tension, alternating-current, with transformers for incandescent lighting to reduce the current to low voltage for any consumption.

Each system has its advantanges and disadvantages.

ELECTRIC LIGHTING.

	System of Lighting.	Arc lamps.			Incandescent lamps.			Underground or overhead wires.	Cost of lighting the streets compared with gas.	Price to private consumers.	Observations.
		No.	C.P.	Per hr.	No.	C.P.	Per hr.				
	Continuous low-pressure three-wire	6	1,000	—	1,500 50	16 20	— —	Underground	—	6d. per unit	—
	High-tension alternating-current	50	1,200	—	4,000 190	16 32	— —	Overhead	Estimated £600 per year more than gas for the limited area	6d. per unit	—
	Continuous, also alternating-current		—			—		—	—	8d. per unit	—
Co. ı Co.	Brush series and transformers Thomson-Houston		2,000	1½d.		{28 56	0·3d. 0·6d.	Underground	—	8d. per unit	—
	—		—		6 71	15 32	per ann. 2 14 0 5 8 0	Overhead	—	—	—
ham	Streets: Thomson-Houston	81	1,200	per ann. 25 7 6	None		—	Underground	£724 more than gas	—	—
.C.	Private: Brush, alternating Thomson-Houston	21	1,200	—	85	20	—	Both	About the same	6d. per unit 1/- per c.p. per annum	—
	—		None		193	16	—	Underground	Double light, 2½ times greater	—	—
ʟ.C.	Thomson-Houston	29	1,200	per ann. 22 10 0 1½d.	1	36	per ann. 5 0 0	Overhead	Double, but so much more light	1/- per c.p. per annum.	—
n Co.	Thomson-Houston	34	1,200	per ann. 22 0 0 1·6d.		—		Overhead	About the same	8d. per unit	—
n Co.	Thomson-Houston		—		112 1	20 200	} ann. 2 5 0	Overhead	Never lighted by gas	9d. per unit	—
Co.	Direct-current arcs and transformers	19	2,000	per ann. 22 10 0 —	212 2	32 50	} ann. 2 6 10	Overhead	Nearly same, but have better light	1/-; to be reduced to 10d.	A
.L.C.	Brush	16	1,000	per ann. 35 0 0 3¼d.		—		Underground	E.L. £652, gas £220	10d. per unit.	—
.C.	Low-pressure	2	1,200	¾d.	16	8	0·12d.	Overhead	E.L. £200, gas £400	5d. per unit	—
	Anglo-American Brush		None		25	20	per ann. 3 0 0	Underground	—	—	—
	High-tension, alternating-current with transformers	2	1,500	per ann. 42 0 0		—		Underground	—	4½d. per unit	B
	Mordey-Victoria, alternate-current with transformers		—			—		—	—	—	C
	{Alternating-current with transf'm'rs continuous-current low-pressure and storage batteries		—			—		—	—	7d. per unit	C
	Continuous-current, low-pressure 115 volts		—			—		Underground	—	6d. per unit	C
	—		—			—		—	—	—	C
	—		—			—		—	—	—	C
	Thomson-Houston, with Mordey alternators	—	1,000	per ann. £9 to 13	1/- pr. c.p. pr. ann.			—	—	—	D
	—		—			—		—	—	—	E
L.C.	High-tension parallel	1/- pr. c.p. pr. ann. 1	300	—	730	17	—	Overhead	—	1/- per c.p. per annum.	C
	—		—			—		—	—	—	C
	—		—			—		—	—	—	C
	—		—			—		—	10 p.c. less than gas	—	C
7 Co.	Low-tension, direct-current and secondary batteries		—		10000	12&16	0·4d. 0·4d.	Underground	—	7d. per unit	F
ʟ and :d.	Low-tension, 120 volts		—			—		Overhead	—	Same as gas	F
Supply l.	Low-tension, direct-current		—			—		Underground	—	—	C
	—		—			—		—	—	—	G
	—		—			—		—	—	—	—
on Co.	—		—			—		—	—	—	—
	—		—			—		—	—	—	H

Observations. — A. E.L. 16,000 c.p., and gas after 11.30; gas alone, 926 c.p. B. Experimental only. C. Private lighting only. D. Tender for lighting streets not accepted, as it would cost double price of gas. E. Only in use in N.B. Railway Station. F. No public lighting. G. Tried E.L. some years ago, but was given up; too costly; E.L. company formed. H. E.L. company formed.

NOT

[N.B.—We have, owing to space required, left out columns stating the number of hours per annum the lamps run, the date of provisional order, the motive power used (it is steam with two or three exceptions, where water power is used), the demand for such lighting, and the date the lighting commenced.—Ed. *E.E.*]

1. The low-tension direct-current system presents an absolute reedom from danger, but the enormous increase in the size of the copper distributing mains precludes its economical use, except in densely-crowded areas of large towns; it is in operation at Bradford, St. James and Pall Mall, London, Liverpool, and Bacup.

2. This system enables a smaller plant to do the work, as the engines run all day and charge the storage batteries in readiness for the dark hours when the output is greatest. The batteries then give out the electricity stored during the day, and so assist the engine power in keeping up the supply; the batteries will also feed the mains during the night after the heaviest part of the lighting is shut off, in the case of all-night lighting. The disadvantage of this method of lighting is the great cost of installation, owing to the high price of the storage batteries and heavy charges for renewals; it is in operation at Chelsea and at Kensington, London.

3. It is by this system that the lighting of the greater number of towns is effected, and its advantages appear to be greater adaptability to the various requirements of the majority of towns, simplicity of machinery, and less cost of installation.

While admitting that in many towns, especially those containing dense areas, where the greater cost of installation is necessarily not the most important item, the low-pressure system is the most suitable, I am of opinion that the high-pressure alternating-current system is the one more likely to be found best for the requirements of this town. I base my opinion of its suitability upon the success that has attended its use at the towns where I have seen the system in operation.

I have seen the various systems in operation at the following stations, of which a brief description may be of interest:

(1.) LOW-TENSION DIRECT-CURRENT SYSTEM.

St. James and Pall Mall, London.—This is a typical station on this system and is eminently suitable for such a closely-confined area, the company having powers for supplying the parish of St. James, Westminster. The dynamos are supplied by Messrs. Latimer, Clark, Muirhead, and Co., and Messrs. Siemens Bros. and Co., and when complete there will be 12 sets of engines and dynamos. I ascertained that the cost of production per unit sold at 7d. was as follows: Coal, 1·01d.; superintendence, 0·26d.; wages, 1·42d.; sundries, 0·41d.—total, 3·1d.

(2.) HIGH-TENSION, DIRECT-CURRENT, WITH SECONDARY BATTERIES.

Chelsea, London.—This is a station worked on the principle of accumulators in sub-stations at various convenient points in the district, which are charged at high pressure from the central generating station, the current being discharged from the accumulators at low pressure. The work of the accumulators is supplemented by continuous-current transformers, and feeding mains are run to various points on the discharging circuits. The mains are laid in a network and are all underground. The generating machinery was supplied by the Brush Electrical Engineering Company, the wiring by the Callender Bitumen Company, and the accumulators by the Electric Power Storage Company.

Kensington, London.—The system adopted here is very similar to the one previously described at Chelsea, but the accumulators are not subdivided at various points. I may say that I have never seen such brilliant and satisfactory illumination as at Kensington, the lighting there having an exceedingly beautiful effect.

(3.) HIGH-PRESSURE ALTERNATING CURRENT.

Sardinia-street, London.—A station of the Metropolitan Electric Supply Company. The whole of the plant has been laid down by the Westinghouse Electric Lighting Company. It is a very complete and typical station on the alternate-current transformer system. The dynamos are of the Westinghouse alternate-current type, and the wires are laid underground. The lighting is used for private purposes only.

West Brompton, London.—The Kensington station of the House-to-House Electric Light Company. This is a splendidly equipped station, the whole of the dynamos being uniform, of the Lowrie-Parker type, with Lowrie-Hall converters. The wires are underground, and the lighting is at present confined to private purposes.

Weybridge, Surrey.—The streets of this town had never previously to being lighted by electric light, been lit at all; they are now lighted by 111 incandescent lamps of 32 c.p., each lamp burning from dusk to 1 a.m., and costing £2 per year, or £222 for the total. I think the lamps are too far apart to give the proper effect; such lighting would not be good enough for Tiverton. However, the fault is in the fewness of the lamps and not in the lighting station, which is admirably fitted with two dynamos of the Thomson-Houston type by Messrs. Laing, Wharton, and Down, the engines being duplicate vertical, compound, of 75 h.p., by Browett and Lindley. The wires are overhead, and the glow lamps fixed on brackets 15ft. from the ground.

Woking, Surrey.—At present only private lighting is carried out at this town; the streets are not lighted. The plant, capable of supplying 2,000 16-c.p. lamps, was manufactured and erected by Messrs. Woodhouse and Rawson. The dynamos are of the Kingdon type, which are claimed to be capable of working arc and incandescent lamps at the same time on different circuits, and so obviating the necessity of dynamos specially for arc lamps.

Fareham, Hampshire.—This town, which is about the same size as Tiverton, is very efficiently lighted entirely by electric light—arc lamps in main thoroughfares and glow lamps in side streets. The illumination in the main streets is all that can be desired, but [illegible] me. The glow lamps do not appear to have [illegible] not manifest to gas of the same candle-power, and judging from this example I am inclined to doubt the wisdom of replacing gas lamps by glow lamps, unless the candle-power is much increased or they are placed closed together, or for the same reason as at Fareham, so that all the lighting may be supplied from one source. The dynamos are supplied by Messrs. Laing, Wharton, and Down, and the wiring is overhead. The cost of lighting is almost the same as formerly by gas, but as regards the main streets is immensely superior to gas. The lighting is done by a local company paying a dividend of 5 per cent.

Bournemouth.—The lighting station is two miles out of the town, and is so placed for convenience of coal sidings, being adjacent to the railway. The engines and plant have been manufactured by the Brush Electrical Engineering Company, and the dynamos are of the Mordey-Victoria alternate-current type. The capacity of the station is equal to 4,000 to 5,000 10-c.p. lamps, and is worked by a local company. The lighting is used at present for private purposes only, but the station will be equal to the public lighting of the town when required; the wires are overhead with a few exceptions.

Taunton, Somerset.—The pioneer town of public electric lighting. This town was first lighted five years ago. The first lighting station being too small for the requirements, a new station has been erected. The electrical plant has been laid down on the Thomson-Houston system, by Messrs. Laing, Wharton, and Down. A small Elwell-Parker plant charges accumulators in various parts of the town for motive power. A portion of the streets of the town are lighted by 31 arc lamps at about 100 yards apart; the lighting is said to be about double that of the gas lamps but this is more than compensated for by the extra li is a very good demand for private lighting, and consu themselves greatly in favour of the light. The local co a share capital of £20,000, and has paid 5 per cent. the and 6 per cent. the second year.

Bath, Somerset—The principal streets are well lighted lamps. The Thomson-Houston plant laid down by Mes Wharton, and Down is used for the arc lighting, and the for incandescent lamps are the Mordey-Victoria altern plied by the Brush Electrical Engineering Company. are underground, and the cost of the light is about more than gas.

Exeter, Devon.—This station at present supplies ele for private purposes only. Thirty arc and about 2,00 cent lamps are in use; the Thomson-Houston dynamo for arc lighting, and the Brush system for incandesc The concern is worked by a local company, with a £25,000 in £10 shares, and the company do their own and sell fittings. The station is fully equipped to than double the present output, and all the machinery cate. The electric lighting companies at Taunton, Exeter owe their existence in each case to the enterp H. W. Massingham.

Lynmouth and Lynton, Devon.—This is a small insta public and private lighting by incandescent lamps, lamps being of 32 c.p. and 200 c.p. The plant was suppli Brush Electrical Engineering Company, and the dynam Mordey-Victoria alternators; power is obtained from 14in. in diameter, developing 200 h.p., worked by wate River Lynn, having a fall in a 30in. pipe of 95ft. The w been carried out by Mr. Green, of Okehampton.

LAMPS.

The lamp generally used for street lighting purposes lamp of 1,000 c.p. to 2.000 c.p., usually 1,200 c.p. the incandescent lamps, of from 8 c.p. to 50 c.p., being gene for private lighting.

Incandescent lamps of 16 c.p. and 32 c.p. have been tried lighting, but have not proved satisfactory. For the streets the plan of using arc lamps in the main thorough incandescent lamps in side streets and at points where is needed, answering well where proper attention is pa situation of the lamps.

The charge made for an arc lamp of 1,200 c.p. varies per lamp per hour at Galway to 3½d. at Eastbourne, or to £35 per lamp per annum, and for incandescent lamps per annum for 10 c.p. at Bath, to the more usual charge candle-power per annum.

The price by meter, according to the Board of Trade from 4½d. at Newcastle to 10d. at Eastbourne.

WIRES.

Most of the earlier installations were laid down with wires, but the great danger and obstruction caused by well as their unsightliness, has led to strong opposi underground wires are now being laid down as a rule.

I may mention Bath as a very good instance of a lighting of which is well laid out with the wires underg

While I hope Tiverton will never be so disfigured as have been, and that the Council will not allow overh in the town, there would not be the objection to overhe between the lighting station and the town, in the eve station being situated at some distance from the town.

POWER.

Steam power for working the machinery is usually and in all cases said to be perfectly satisfactory.

Water power is used with success at Okehampton, Galway, and Greenock. I believe that water power obtained from the River Exe sufficient for the purpose of this town, and if so, an immense saving in coal, boilers, power [illegible] will be the result; the only period whe dry summer, [illegible] available, will be for about two mo if this is found to be so, a [illegible] lighting will be at its lowest an auxiliary, which would be [illegible] steam plant could be laid requiring to be done to the water machine[illegible] in the event of

At any rate, the question is such an important one that I the Council will act wisely in fully investigating the matter.

If water power be used, the lighting station must be situ some miles up or down the river—this (independently of the cost wiring the distance) will be no serious difficulty. At Bournem the lighting station is two miles from the town, and no objection is felt.

I have enquired into the question of gas engines, but they not made of sufficient capacity for town lighting, unless a num of engines are used, nor can they compete with steam unless can be produced at from 1s. to 1s. 6d. per 1,000 feet. The Dow Economic Gas Company claim to be able to produce the (made by passing superheated steam and air through red-hot or coke) at an equivalent to this price, but in my opinion small units of engine power rendering so much attendance necessary is fatal to its use for central station work.

The power required for driving the dynamos for arc lighting from ½ h.p. to ¾ h p. per 1,000 c.p. of light produced, while will drive about 10 16-c.p. incandescent lamps.

The horse-power required for such a plant as would serve the purpose of this town for some years, say, 30 arc lamps and 2,0 andescent lamps, would be from 75 h.p. in the summer, in the winter.

Comparison of Cost with Gas.

arison of the cost with that of gas, although a question portance in considering the advisability of embarking on dertaking, is one of extreme difficulty and complexity, so nts having to be taken into account in making the com-

oss amount paid for each illuminant, the amount of light each, and the relative adaptability or usefulness of the illuminating purposes, are all points that must be careghed; but, taking all things into consideration, it seems een estab'ished by the experience of most towns that the e cost of public lighting by electricity exceeds that of that the light given is much more intense and useful for mination. At the same time, I must instance one case—Fareham, a town of about the same size as Tiverton—e public lighting is carried out very efficiently, in my at about the same cost as the former charge for gas

Provisional Order.

ying out the terms of the provisional order, there are two ves before the Council: (1) To carry out the lighting of themselves. (2) To transfer their powers under the other persons for a specified term, with the power of at the end of the term.

t my duty to strongly recommend the Council for the ot to adopt the first alternative; everyday improvements nces and machinery are being made, and a public body is to so readily alter appliances and methods as is a manu-company, who are at all times in the market.

nmend that the Council advertise for offers from persons nies to undertake the powers of the provisional order for ed term, the undertakers to specify: 1. The system or they propose to employ. 2. The charges they intend to 3. The date on which they will commence the lighting. erms on which the Corporation may, at the expiration of , purchase the plant belonging to the undertakers. Or, assistance of the Council, a local company might be n the town, to whom the powers of the order could be ed.

further details as to the lighting of other towns may be from the tabulated statement I have prepared (see pp. 525), and with a hope that the information laid before them useful to the Council in this most important matter.—I lemen, yours obediently,

J. Siddalls, Borough Surveyor.

PROVISIONAL PATENTS, 1891.

November 16.

lectric spiral lamp for general lighting purposes for ailway carriages, tramcars, and cabs. William Gordon otter and Charles Midgeley, 8, Middle-pavement, ottingham.

nprovements in gravity control, as applied to electric easuring instruments. William Alfred Crook and enry John Payne, 1, Riverview, The Terrace, Barnes, urrey.

nprovements in dynamo brushes. James Dickson and obert George Shapcott, 4, South-street, Finsbury, ondon.

November 17.

nprovements in incandescent electrical lamps. James tkinson, 3, Nassington-road, Hampstead, London.

nprovements in telephone closets, and other structures here it is desirable that they should be practically ound-proof. Thomas Weighill, 6, Lord-street, Liverpool.

nprovements in or relating to welding or working etals electrically. William Phillips Thompson, 6, Lord-reet, Liverpool. (Charles L. Coffin, United States.) omplete specification.)

nprovements in or relating to welding or working etals electrically. William Phillips Thompson, 6, Lord-reet, Liverpool. (Charles L. Coffin, United States.)

nprovements in telephonic transmitters. Alexander larr, 70, Market-street, Manchester.

nprovements in or connected with electric arc lamps. ohn Brunswick Barton, 34, Southampton-buildings, ondon. (William Jandus, United States.)

n electric lamp for lighting and signalling at sea nd land and for deep-sea fishing. William Gordon otter and Charles Midgeley, 8, Middle-pavement, ottingham.

n electric cable seating for laying in the cable for ouse-to-house supply for laying in the wires. Villiam Gordon Potter and Charles Midgeley, 8, Middle-avement, Nottingham.

nprovements in magnetic separators. William Durant offman, 6, Bream's-buildings, London.

nprovements in and relating to conduits for electric onductors. John Charles Love, 45, Southampton-uildings, London. (Complete specification.)

19968. **Improvements in electric motors and dynamos.** Martin Charles Burt, 115, Cannon-street, London. (Complete specification.)

19971. **Improvements in or connected with electrical measuring and indicating apparatus.** Erhard Ludwig Mayer, Norfolk House, Norfolk-street, London.

19972. **A new or improved device for varying the resistance in telephone circuits.** Erhard Ludwig Mayer, Norfolk House, Norfolk-street, London.

19975. **Improvements in and relating to electric arc lamps or lighting apparatus.** Frederic Victor Maquaire, 3, Avenue du Maine, Paris, France.

November 18.

19996. **Improvements in electric alarum clocks.** James Nicholls, Lowtown, Pudsey, near Leeds.

20026. **Improvements in multiple switchboards for telephone exchanges.** Guillaume Arnaud Nussbaum, 29, Ludgate-hill, London. (Louis Mandroux, France.)

20033. **Improvements in dynamo-electric machines.** Samuel Dickinson Williams, Moorlinch House, Clytha Park, Newport, Monmouth.

20059. **An electric gondola.** Jessie Hutchinson, 11, Furnival-street, London.

20063. **Improvements in the use of transformers.** John Ambrose Fleming and Reginald Thomas Dudley Brougham, 28, Southampton-buildings, London.

November 19.

20078. **An improved automatic and electric check-till.** Robert Gay and William Henry Jackson, 5, Clover Hill-terrace, Halifax.

20109. **Improvements in electric switches.** Wilson Henry Sturge, 12, Cherry-street, Birmingham.

20111. **Improvements in methods of electrical distribution.** John Hall Rider, The Northern Telegraph Works, Halifax, Yorkshire.

20139. **Improvements in electric signals or indicators.** John Thomas Gent, Alwyn Walter Staveley, and Isaac Hardy Parsons, 4, South-street, Finsbury, London.

20144. **A new or improved system of communicating visible signals and establishing electrical and telephonic connection between central town and district stations, and mechanism and appliances connected therewith.** Charles Eggar, 96, Buchanan-street, Glasgow.

November 20.

20215. **Improvements relating to electrical machines and to reversing and interrupting apparatus for use in connection therewith.** Cornelius Bennett Harness, 11, Southampton-buildings, London. (Complete specification.)

20217. **Improvements in dynamo machines.** Joseph Sinclair Fairfax, 433, Strand, London.

November 21.

20226. **Improvements in arc electric lamps.** Thomas Barnet Grant, 15, George-street, Mansion House, London.

20230. **Improvements in electric arc lamps.** John Hall Rider, Northern Telegraph Works, Halifax.

20234. **A method of and apparatus for telephonic transmission.** Erhard Ludwig Mayer, Norfolk House, Norfolk-street, London.

20247. **Improvements in solenoids, particularly applicable to automatic sound signalling apparatus, but which may also be used for other electrical purposes.** John Stirling Yule and Charles Kerr Marr, 62, St. Vincent-street, Glasgow.

20257. **An improved electric arc lamp.** William Phillips Thompson, 6, Lord-street, Liverpool. (La Compagnie de l'Industrie Electrique, successor and representative of La Société d'Appareillage Electrique, Switzerland. (Complete specification.)

20279. **Improvements in electric cables.** George Gatton Melhuish Hardingham, 191. Fleet-street, London. (The firm of Felten and Guilleaume, Germany.)

SPECIFICATIONS PUBLISHED.

1890.

19034. **Electrical testing apparatus.** Jones and others. 6d.

20898. **Dynamo-electric machines.** Leigh. (Desroziers.) 8d.

21116. **Electric arc lamps.** Gay and Hammond. 8d.

21224. **Telephonic circuits.** Abel. (Société Générale des Telephones and another.) 8d.

1891.

1069. **Gas, electric light, etc., lamps.** Brookes and Ward. 8d.

1905. **Distributing electric currents.** Atkinson. 8d.

12799. **Electric distribution.** Feilbogen. 6d.

13503. **Electric machines, etc.** Dobrowolsky and others. 11d.

14388. **Electric motors.** Dymond. (Gutman.) 8d.

14633. **Connecting electric wires.** Shiels. 8d.

14764. **Dynamo-electric generators, etc.** 8d. Thompson. (McLaughlin.)

16522. **Electrically soldering metal.** Thompson. (Coffin.) 6d.

16526. **Electric arc lamps.** Lake. (Tweedy.) 4d.

Danvers, Augustus Stroh; hon. solicitors, Messrs. Wilson, Bristow, and Carpmael.

Utilisation of Water Power in France.—A large scheme is announced for tender for the utilisation of the power of the River Dranse, tributary of the Rhone, near Martigny, Valais. The fall is 200 metres, volume of water 5,000 litres per second, and the total force therefore about 10,000 h.p., allowing 25 per cent. loss. The estimated cost is about 1,400,000f. (£56,000) for works, races, and reservoirs. The company only desire to utilise 6,000 h.p. at first, and opens to competition projects for its utilisation in establishment of works for electric manufacture of aluminium, chlorate of potash, and electro-metallurgy, great latitude being allowed as to propositions. A description of proposed works and processes, a general plan, an estimate of first cost, and a description of the carrying on of proposed works are desired. For this premiums will be given, but only a restricted number of competitors will be received; several persons or firms may join. The projects must be sent by the end of February, 1892, for the Société des Eaux de la Dranse, to MM. Cuenod-Churchill et Fils, banquiers, Vevey (Vaud) France under motto, sealed. A premium of 4,000 francs will be awarded to the author of the best project, and a second premium of 2,000 francs to the next best; a third premium of 1,000 francs will be given or not as found desirable. The projects will remain the property of the company.

Secondary Batteries.—The electrical public are particularly favoured lately with text-books on special subjects, but hitherto there has been a decided lack of aggregated information upon the subject of the different kinds of storage batteries or accumulators and their principle and manufacture. We gave a few months ago a very interesting series of articles by Mr. J. T. Niblett, now the general manager of the Mining and Electric Lamp Company, on "Secondary Batteries," the embodiment of a paper read before the Glasgow Physical Society. These articles reprinted were very soon exhausted, and we are now able to announce that these articles, thoroughly revised and with much additional matter, fully illustrated, will be published shortly from the office of this journal in book form, price 2s. 6d. It will include a description of all the recent developments of practical storage cells, together with numerous curves, tables, and data, in four parts and an appendix. Part I. will deal with lead plates of the Planté type, Part II. with lead peroxide cells of the pasted or Faure type; Part III., lead-zinc, copper zinc, alkaline, and other forms; Part IV., solid storage cells; and also the electrolyte and methods for measuring its density. The appendix will deal with electrical measurements as applied to storage cells; materials used in construction, with other practical information and figures.

Electric Light Lectures.—We give in another column a portion of a lecture by Mr. Guss Metzger, which was delivered at Hendon on Monday last, together with the discussion which followed. The lecture contains nothing that is new, but the discussion shows very plainly how little a knowledge of even the elementary facts connected with the distribution and utilisation of electrical energy are known or appreciated by the general public—that is to say, by the very people to whom electrical engineers are looking for the adoption of electric lighting. What Mr. Preece said the other day at the Mansion House meeting was quite true. The application of the productions of the electrical engineer are only limited by the ignorance of the public. Well! why not educate the public, and as the public won't be educated of its own accord and initiative, we must perforce gather them together in small units and lecture at them. Such lectures as that of Mr. Metzger, though very elementary, want to be given in every hole and corner of the United Kingdom, and the more the audience can be stirred up to ask questions the better. In fact, a confederate on these occasions to set the ball rolling by putting a poser to the lecturer is not only permissible, but necessary. Once start the queries and they will only be limited by the number of tongues present. An interest in the matter will have been aroused which will probably lead to certain of the energetic spirits finding out more for themselves from papers and books. We want more of these elementary lectures, even though they be in the nature of advertisements of one particular system. If the ignorance of the public stands in their way, electrical engineers should see that it is removed.

Nottingham.—At the next meeting of the Nottingham Town Council, on December 7, the Electric Lighting Committee will report that, in pursuance of the resolution of the Council passed in May last, they have obtained the services of two experts to report on the action which should be taken by the Town Council under the provisional order of the year 1890. These experts are Dr. J. Hopkinson, F.R.S., and Mr. W. H. Preece, F.R.S. Both concur in the opinion that the Town Council should undertake the electric lighting of the borough under the powers of the provisional order, and by no means to allow such powers to fall into the hands of private companies. They also are of opinion that any capital invested in electric lighting by the Corporation will not only return a fair percentage upon the outlay, but ultimately be a source of profit. The committee unanimously concur in the recommendation of the experts with respect to the propriety of the Town Council undertaking the electric lighting of the borough under the provisional order, thereby preventing a monopoly of the electric lighting falling into private hands. The committee add that they cannot fully concur in the expectation of the experts that for some time to come the supply of electricity to the borough could be made a source of profit. They are of opinion that this is an over-sanguine view of the question. They are, however, unanimously agreed that the time has arrived when the town should have the benefit of electric lighting, and that the responsibility should be undertaken at once. Whatever may be the pecuniary result for the first few years, it will be of more advantage to the town than allowing a monopoly to be created in the hands of private persons, which might have to be repurchased on extravagant terms. The committee recommend that the electric lighting should be undertaken at first in a tentative way, and that the compulsory area only should be at first provided for. They recommend that they should be authorised to prepare a specification of the works required, and to engage such professional assistance as they may require.

Edison's New System.—The public interest which was recently aroused by the announcement of a new electric railway system by Edison has hardly yet subsided, and while the public no doubt believe a wonderful discovery has been made, and then probably forget all about it, yet electrical engineers are wondering what foundation there is in all the varied and brilliant reports. Our esteemed contemporary and namesake of New York has sent up a special representative to interview Edison, and find out what really is being done, or rather proposed. It seems that Mr. Villard, as long ago as 1880, applied to Mr. Edison to devise a system of electric railway which should be cheap of operation, and act as branch feeders to the main lines. More recently Mr. Villard, having become president of the Edison Company, requested Mr. Edison to devise a street railway system without trolleys, and of simple

SOLAR STRESS CONSIDERED AS THE CAUSE OF TROPICAL HEAT.

BY DR. SHETTLE.

In the *Electrical Engineer* of November 13th, I endeavoured to define the manner in which solar and lunar stress are productive of terrestrial magnetism. In the following remarks I wish to show the mode in which it would appear that *solar stress is productive of heat.*

Before attempting to establish my points it will be well to call attention to certain well-known facts which are very pertinent to the enquiry. These are:

1. That whilst it is well known that all bodies expand during the process of being heated, the cause of the expansion is not known.
2. That as the earth retains its shape and motions, we have proof that whilst the centripetal must be in excess of the centrifugal force, yet the one is so adjusted to the other that the normal conditions are maintained.
3. That constant and regular changes are occurring in atmospheric pressure, which coincide with the relative positions of the sun and the earth.
4. That whilst Joule's law shows that a definite quantity of heat is capable of being transformed into a definite quantity of mechanical work, "combustion is a complete illustration of the potential, latent, intrinsic energy becoming active or kinetic, and taking the form of heat."

Taking the above as the fundamental principles upon which the theory is based, I will deal with them in what appears to be the order of importance; and, as it would seem that all matter would be resolved into a thin ethereal vapour were it not affected by gravity, gravity must be considered first.

In gravity we have a force by which "every portion of matter attracts every other portion of matter, and the stress between them is proportional to the product of their masses, divided by the square of the distance."

Consequently we find that whilst every atom of matter in the earth, or in the sun, is being drawn to the centre of each body by terrestrial or by solar gravity, as the case may be, there is a secondary manifestation of stress between the two bodies as masses, which stress, in proportion to its intensity, counteracts the central tendencies of the atoms. Thus as the earth performs its axial and orbital motions, and retains its shape under the influence of terrestrial gravity, we recognise that the centripetal must exceed the centrifugal manifestation of force. But as a certain amount of bulging exists in the equatorial regions, it is evident that the centripetal has not absolutely controlled the centrifugal manifestation.

This bulging of the earth's surface is unquestionably due to solar and lunar stress, but it also signifies that terrestrial gravitation is proportionately less in the equatorial regions. It is produced by atomic leverage, as I described in my paper on magnetism. The tides give ocular proof of the mechanical effect of the stress on the liquid part of the earth's surface, where friction is reduced to a minimum.

But when we consider the effects of solar stress in the production of heat we recognise:

1. That the intensity of that stress on the surface of the earth must vary with the relation which any part holds to the line which passes through the centre of the two bodies.
2. That in proportion to the intensity of the stress mutually exerted by the two bodies, the pressure consequent upon the central (terrestrial and solar) manifestation of gravitation must be reduced.
3. That in proportion to reduction of central pressure the elastic energy of the atoms (*i.e.*, the tendency of the atoms to resume the ethereal state) must be increased.
4. That in proportion to the expansion of the atoms their inherent potential energy is productive of friction and heat, as in ordinary combustion.

With regard to the polarising influence of stress, and the consequent motion of the atoms under change in the direction of that stress, there can be no question, because every form of matter has a specific description of resistance to the transference of energy, or motion; and this resistance determines the polarity of its atoms, or the line which they assume under stress. This must be the case, because the same law holds good with the atoms as with the mass: the greater contains the less.

We further perceive that if the surface heat of the earth is caused by the elastic energy of the atoms, when relieved from gravitational or centripetal attraction by solar stress, it follows that the heat of the sun and of any similar body can be kept up on the same principle without any diminution of energy; and thus the theory of the conservation of energy is supported, even in its application to the maintenance of solar heat.

THE DISTRIBUTION OF ELECTRICAL ENERGY.*

BY W. C. RECHNIEWSKI.

(Continued from page 371.)

Utilisation of Water Power.—The most favourable case for the utilisation of water power, though, unfortunately, one not very often met with, is that where the fall of water is situated in the centre of the district to be lighted.

The construction of the works required may be more or less difficult, and, consequently, costly. Taking 40,000f. (£1,600) for this work, including the erection of turbines, we shall be considering a favourable case. Under these conditions, the cost of establishment of a 200-h.p. station may be calculated as follows:

	f.	£
Water works and buildings	40,000	(1,600)
Three 100-h.p. turbines (one spare) with accessories and gearing for dynamos	20,000	(800)
Three 100-h.p. dynamos	30,000	(1,200)
Switchboard and instruments, etc.	10,000	(400)
Total first cost	100,000f.	(£4,000)

This is 45,000f. (£1,800) less than the first cost of a steam-driven central station. This price, however, depends essentially upon difficulties of dealing with the water supply, and may become very much higher.

The cost of maintenance may be calculated as follows:

	f.	£
One electrical engineer	3,600	
Two mechanical engineers	5,200	
10 per cent. depreciation and repairs on 60,000f. (machines)	6,000	
5 per cent. on 40,000f. (buildings)	2,000	
5 per cent. interest on 100,000f.	5,000	
Total	21,800f.	(£872)

It is seen, then, that if it were desired to double the power of the station, either 100,000f. worth of accumulators could be added, or the mechanical power of the station could be doubled; the annual expenses, as well as the first cost, would be practically the same in the two cases, taking, of course, a mean duration of two hours per lamp per day.

In practice it would be preferable, if there were sufficient hydraulic power at disposal, to double the mechanical installation because of the simpler working of turbines and dynamos, and more particularly because of the possibility of employing this motive power to run electric motors in the daytime. The use of accumulators would be left to those cases where the hydraulic power is insufficient; this arrangement then enables the output of the station to be doubled without very great expense. This solution is that of the future, when it will be necessary to utilise to the utmost all natural forces; indeed, places where there is more power than required are sufficiently rare already, and will become more and more so as the use of water power increases.

Alternate Currents.—The use of alternate currents is no advantage except where power is required to be transmitted to a considerable distance. As, however, the alternate-current system is used in some cases, even for small and thickly-populated districts, we shall consider these cases, taking, in the first place, the cost of lighting by alternate currents of a district of 500 metres radius with 3,500 lamps of 10 c.p.

---

* Translated from *L'Electricien.*

and supplies active material to replace that lost in the working of the cell.

In the new 1890 pattern E.P.S. plate, an early form, introduced originally by Swan, has been resorted to. The plate is grooved, but instead of the grooves being vertical, as in the Tudor plate, they are horizontal, and the ridges between the grooves curve slightly upwards towards the surface of the plate, forming a lodgement for the paste.

2. The support is some form of "grid," that is, is perforated with holes, as in the old pattern E.P.S. plate, and the Julien grid, Fig. 2.

A great many varieties of this form of plate have been suggested, and the apertures have been made by casting the grid in a mould, and by punching. Their form has been cylindrical, barrel-shaped as in Messrs. Drake and Gorham's positive plates, shaped like two cones joined at the apices, and to give greater security the perforation has been made to expand again just at the junction of the apices.

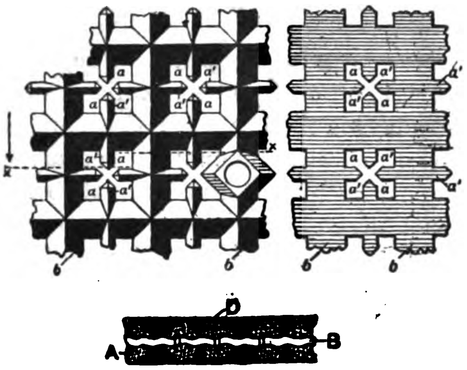

Fig. 6.—"Robert's" Cell: Detail of Plate.

The construction of a mould, to produce a perforation expanding inwardly, is a matter of difficulty, and therefore the grids are sometimes cast in two halves and subsequently joined, as in the Gadot cell, Fig. 3. In the Correns cell, Fig. 4, much used in Germany, the grid takes the form of a double lattice.

3. The active material is enclosed in a perforated conducting retaining vessel.

In this case, also, the devices resorted to have been very numerous. Plain or corrugated sheets of lead have been taken and folded into boxes, either before or after applying the paste.

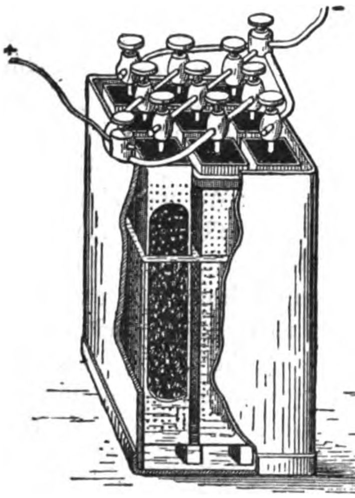

Fig. 7.—Tommasi Cell, Corner cut away to show Internal Arrangement.

In the Roberts cell, Fig. 5, two grids are taken, pasted on one side, and then united to form a plate with the paste inside, Fig. 6.

In Dr. Tommasi's multitubular cell, Fig. 7, the retaining vessel may be constructed of metal, but is usually of some non-conducting material, and so comes under the next heading.

4. The enclosing vessel or plates are made of some non-conducting material, or some inactive material is packed between the plates, to prevent short-circuiting, and retain the active material.*

In France the plates have been covered with perforated sheets of celluloid; Reynier brought out what he called an "elastic cell," specially designed for use on torpedo-boats. When tried in 1886, on board "La Gymnote," it was not a success, and the alkaline copper cell was preferred to it. Since then, however, the construction has been much improved, Fig. 8. Each cell, according to improvements effected in 1889, is composed of one positive, two negative plates, and four porous partitions held together, as shown by a frame consisting of two end plates connected together by corrugated strips of metal, which have sufficient elasticity to enable them to expand and contract with the alteration in volume of the plates caused by charge and discharge, Fig. 9.

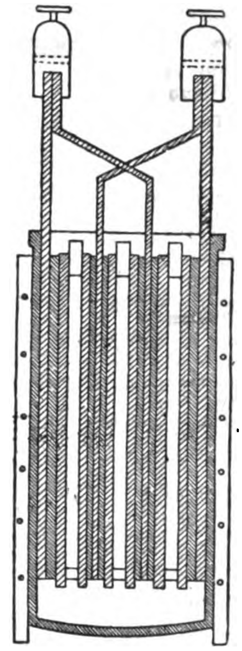

Fig. 8.—Reynier Element, Side View.

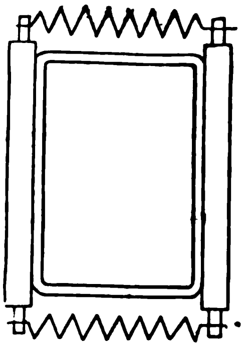

Fig. 9.—Reynier Element: Plan of Compressing Arrangement.

In this country Mr. Barber-Starkey has tried filling in between the plates with a mixture of plaster of Paris and sawdust; Mr. Fuller uses porous pots; and in the United States, in the Pumpelly battery, cellulose, or wood pulp, is used to separate the plates which are arranged horizontally, as in the Atlas cell, Fig. 10.

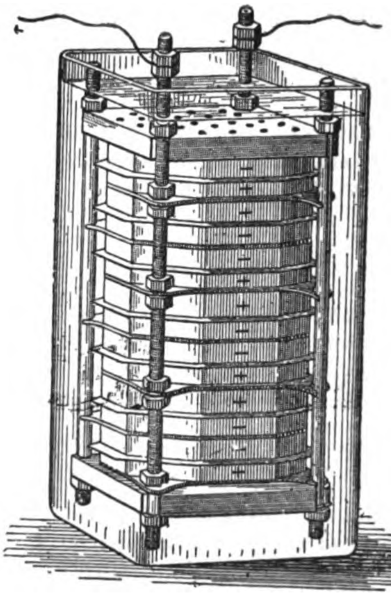

Fig. 10.—"Atlas" Cell.

(Continued on page 541.)

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* The improvements under this heading are equally applicable to cells of the Planté type; but as they are more frequently applied to cells of the Faure type, I refer to them under this heading.

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ADVICE RE THE PALACE EXHIBITION.

It is not often that we find ourselves thoroughly in accord with Colonel Gouraud, but his advice to exhibitors at the meeting in connection with the Crystal Palace Exhibition was sound and to the point. We had previously pointed out that at every exhibition of repute some firm or firms had laid a solid foundation for a reputation and for business abilities that rapidly led to increase of business and to fortune. Colonel Gouraud merely completed our suggestion by expressing in plain language the fact that a good exhibit requires a certain expenditure of money. There is, however, one other point which is worthy the closest attention. A day will be fixed for the opening of the exhibition. Already rumours are current as to the unreadiness of some of the exhibitors, and it is with these we wish to "wrastle." The only aim an exhibitor can possibly have nowadays is the necessity of keeping his trade or of increasing it. He exhibits because he cannot allow his rivals to gain a point in the race, and his returns are derived from various sources. In the first place, he may effect actual sales to customers who visit the exhibition. In the next place, by circulars handed to visitors and by explanations given to visitors, the exhibitor becomes acquainted with probable future buyers. The fad of having seen apparatus and knowing a firm are often vital points tending to direct orders in specific directions. Lastly, there is the wide advertisement to the four quarters of the globe given of apparatus by the descriptions which appear in the various papers. If we say that we intend to describe this exhibition from start to finish—and we do say so—it will be found that our contemporaries are bound to do likewise. They dare not lag behind in such a race. What, however, does all this mean to the laggards whose exhibits are incomplete a month or so after the opening ceremony? They have missed the chances of obtaining customers during a time when the greatest interest exists; they have failed to make themselves known as widely as they might, and they can never regain the lost ground. Ofttimes the excuse is: We are so busy; we really have not time to exhibit. That excuse is good enough for a third or thirtieth rate exhibition, but not to one in the national home of exhibitions, to one devoted entirely to electrical matters, to one held just at a time when the widest vista of work ever opened to the eyes of electrical engineers appears before them in the glimpses that can be seen of the immediate future. We would urge upon every exhibitor, then, the importance of being ready at the time of the opening. Firms that are too busy to advertise, too busy to exhibit, too lazy to come up to time, are unworthy of support, and the sooner they are relegated to the background the better. Those firms having a reputation to make, or a desire to retain one they have made, should not pretend to be in the position of "don't care." They exist to do business, and if they are too high and mighty in their opinions customers had better—far better—go elsewhere.

Fortunately, there are, as yet, very few electrical firms who take this tone. There are one or two who imagine the world must wait upon them because they have been lucky in securing a certain amount of orders hitherto. Such firms must die a natural death, and will not survive the keener business spirits for many years. Those who seize the opportunity now offered will, we should imagine, never regret it. They have the chance of making their mark at a far more favourable time than those who were so active in 1882. Black Friday for electrical engineering has come since 1881-1882, and, so far as can be judged, has gone for good. There cannot again be such a rush of blind speculation, of Stock Exchange gambling, but there may be so vast an increase of work that it appals one to attempt to describe the possibilities for an enterprising firm. Once more to reiterate our caution. Be ready in time, if only to obtain the praise of the daily press. Every exhibitor should know that after a few short articles in these papers the whole subject will be practically dropped, and especially so if a turn of the political wheel should bring about some interesting political topic. The exhibits should be worthy the firms' reputations. Explanations should be forthcoming whenever a visitor turns up. Nothing is more annoying than to find some interesting piece of apparatus on a stand with no one at hand to explain its uses and mode of working, and yet more often than not visitors have to pass by with no more information than can be obtained from studying the external framework of a machine. At the Crystal Palace we must have nothing of this sort. A niggardly policy should be eschewed, and the exhibit should be ready at the opening.

LITERATURE.

A First Book of Electricity and Magnetism for the use of Elementary Science and Art and Engineering Students, and General Readers. By W. PERREN MAYCOCK, M.I.E.E. Whittaker and Co., London. Price 2s. 6d.

In deciding the value of a book it is necessary to look at it from the standpoint from which it was written. Mr. Maycock is more or less connected with the Science and Art Department, and necessarily his mind takes a bias in the direction of this department's labours. As a first book for such students as have to pass examinations, it is admirable. The statements are clear, accord with the authorities, amply illustrated, and the information given is driven home by a series of questions given at the end of each section.

Electricity Treated Experimentally for the use of Schools and Students. By LINNÆUS CUMMING, M.A. Third edition. Longmans, Green, and Co. Price 4s. 6d.

A book that has stood the test of three editions hardly needs a godfather. An attempt is made to cover a very wide field in an elementary manner, and undoubtedly the student is led gently and pleasantly onwards. The alterations to this edition are principally connected with the more modern practical developments in apparatus, which are simply described and freely illustrated. The subject is treated under four sections, dealing respectively with Magnetism, Frictional Electricity, Voltaic Electricity, and Thermo-Electricity, with appendices on "Units" and "Table of Sines, etc."

CORRESPONDENCE.

"One man's word is no man's word
Justice needs that both be heard."

VOTES OF GAS SHAREHOLDERS.

SIR,—At meetings of local authorities the question is from time to time raised whether members interested in gas undertakings are entitled to vote or take part in discussions upon electric lighting matters. It may be useful, therefore, to the electrical industry to know what the law on this subject is. Mr. Sydney Morse has had occasion to take counsel's opinion upon the point, and as I have obtained the permission of his clients to publish the opinion which he has obtained from Mr. R. S. (now Mr. Justice) Wright, I enclose it herewith, and trust that its publication by you may help to prevent the continuance of the injustice which is now frequently done to electrical companies by representatives of gas interest.—Yours, etc.,

London, E.C., Dec. 2, 1891. E. GARCKE.

OPINION.

The Urban Sanitary Authority of ——— is the Corporation acting by the Council (see s. 6 of the Public Health Act, 1875), and consequently the present question turns on the construction of s. 22, sub s. (3) of the Municipal Corporations Act, 1882. In my opinion those members of the Council who are shareholders in the gas company have a direct pecuniary interest in the question, whether or not the Council shall give their consent to the application by the electric light company for a license under 45 and 46 Vict., c. 56, s. 3, and such members are not entitled to vote on the question or to take part in the discussion of it. No penalty is attached to a breach of s. 22, sub s. (3), and all that can be done in order to prevent such members from voting will be to get some member of the Council to draw the attention of the Mayor to the fact that the votes in question ought not to be received, and will be invalid. See rule 10 of the second schedule to the Municipal Corporations Act, 1882.

(Signed) R. S. WRIGHT.

45 and 46 Vict., ch. 50, s. 22.

(3). A member of the council shall not vote or take part in the discussion of any matter before the council or the committee in which he has directly or indirectly, by himself or by his partners, any pecuniary interest.

ELECTRIC VANS.

SIR,—Can your readers inform us whether it is yet practicable to convey a van, which with its contents would weigh about five tons, over a common road for 35 miles by an electric motor and accumulator? By "practicable" we mean at an average speed of not less than five miles an hour, at a cost considerably less than that of horses, and without recharging the accumulators during the journey. We shall be glad to have any proposal on the subject.—Yours, etc., HAZELL, WATSON, AND VINEY, LIMITED.

1, Creed-lane, E.C., Nov. 30, 1891.

SECONDARY BATTERIES.

(Concluded from page 539.)

b. Improved Connection Between the Applied Oxide and the Support.—With this object the support has been well rubbed with carbon before applying the paste, and the addition of carbon to the paste in some form has been frequently recommended, as, for instance, kneading the oxides into a paste with lead acetate.

In the Tudor cell, Fig. 11, the positive
treated by Planté's process, to coat them
crystalline electrolytic peroxide. The
partially filled with a paste of peroxide of
is applied to the ridges to expand them,
the mouths of the grooves, Fig. 12.

The casting or welding of the applied
has also been tried, and to overcome the

the substances to blend into one another, caused by the great difference in their melting point, it has been suggested to fill the portion of the mould usually occupied by the support with some reducing agent, such as carbon mixed with nitre, so that when the fused oxides are poured into the mould they will be reduced in part to metallic lead, which will assume the place and shape of the carbon core, while the remainder forms the active material.

General Improvements.—Besides the improvements in what may be called the manufacture of the plates, or electrodes proper, various devices have been resorted to with the view of diminishing the resistance of the lugs, and securing better contact between plates of the same sign, such as making connection by tinned copper rods passed through holes in the lugs. Lead is afterwards cast round the copper, so that it is screened from the action of the acid.

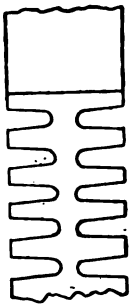

FIG. 11.—Tudor Plate: Side View, Empty.

Some attention has also been given to the question of the best electrolyte to use, some advocating the use of acid of density 1,150 to 1,180, while others recommend a density 1,200 and over. The addition of small quantities of some salt of the alkalies, such as sodium sulphate or carbonate, has been recommended by Mr. Barber-Starkey and others, with a view of reducing sulphating; and Dr. Paul Schoop has brought out a successful gelatinous electrolyte by adding one volume of dilute sodium silicate, density 1·180, to two volumes of dilute sulphuric acid, 1·250.

In order to prevent short-circuiting between the plates by the material dislodged in working, they are now either slung, or rest on supports, which are so placed that the formation of a layer of mud between them is prevented.

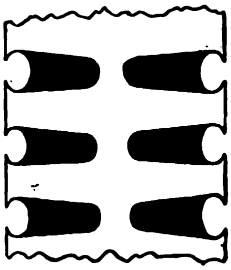

FIG. 12.—Tudor Plate: Side View, Empty.

The equalisation of the chemical action over the surface of the plates has also been attempted, and in the Schoop cell the current enters at the top of one set of plates and leaves from the bottom of the others. The plates also are widely spaced now as a rule, the proportion of acid to plates has been increased, and little alterations are constantly being made to secure the free circulation of the electrolyte essential to regular working.

THE CHEMISTRY OF THE ACID.

Although so many different modes of manufacture and preliminary treatment have been resorted to, all the batteries, so far as I am aware, which depend for their action on the couple formed between lead and lead peroxide in dilute sulphuric acid, exhibit the characteristic peculiarities noticed by Planté in his cell—namely, the high initial E.M.F. of a freshly-charged cell; the fall of E.M.F. on breaking the charging circuit, with corresponding rise on breaking the discharging circuit; the very rapid fall towards the end of discharge which occurs earlier, the more rapid the discharge is, and is not due to the exhaustion of the active material, as after a rest a fresh discharge can be obtained.

As the defects—namely, sulphating and buckling—which have retarded the introduction of reversible lead batteries are also common to the two types, it appeared possible that they were due to the same causes which produced the variations in E.M.F.; therefore, as the work of Dr. Oliver Lodge[*] in 1883, and of Miesel[†] in 1888, had shown that the causes of the variation must be sought either on the lead plate, or in the acid next it, and the chemistry of the plates afforded no explanation.[‡] I last year, with Dr. Armstrong's advice and assistance, undertook the investigations of the reactions occurring in the acid.

Planté had considered that the peculiarities in E.M.F. were due to the formation of peroxides in the acid, and showed that the conditions existing in a cell were favourable to their production, since in voltameters with lead electrodes they were formed in greater quantity than in those with platinum. He also noticed that, immediately on the cessation of the charging current, there was often a small evolution of gas from the peroxide plate; this evolution he ascribed to local action between the peroxide and the subjacent lead.

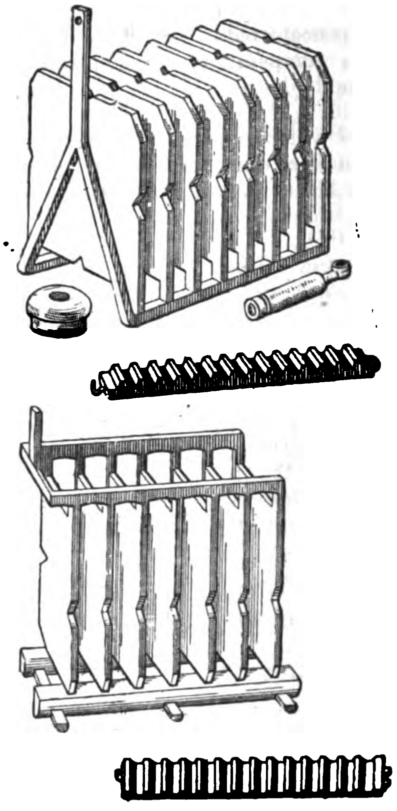

FIG. 13.—Plates of Oerlikon Cell Separated.

Commenting on this, in their little book, "The Chemistry of Secondary Batteries," Messrs. Gladstone and Tribe point out that the gas is oxygen, and cannot be due to local action, since the gas was evolved whether the peroxide was removed from the supporting plate or not. The application of heat increased the evolution of gas, and the gas was oxygen. Testing the acid between the plates, they always found traces of something which decolourised permanganate, and might, therefore, be hydrogen dioxide or ozone.

Although a very large amount of work has been done on the electrolysis of sulphuric acid solutions, and the general character of the change in the nature of the products formed as the strength of the solution is varied, is well understood, the only references I was able to find to any examination of the acid in a battery were those just given; and, therefore, I have ventured to bring the results of my own experiments before this society, not because I consider them a final solution of the difficult problem of acid, the subsequent formation of hydrogen dioxide will be greater in it than in the plain cell. As far as I could discover, sodium sulphate has little or no action on the acid unless it is added during electrolysis, or to acid which has just been taken from a cell through which a current is passing.

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[*] Cantor lecture.

[†] "Monatschafte für Chemie," viii., 713.

[‡] For references and a summary of the principal work done on the cell, see the *Electrician*, vol. xxvii., No. 682, p. 165; No. 692, p. 437.

The Pink Colour of the Acid.—It has often been noticed that during charge, particularly with new cells, a pink colour starts from the peroxide plates, and gradually spreads over towards the lead plates, fading away, however, before reaching them. This pink colour was referred to by Mr. Crompton at a meeting of the Institute of Electrical Engineers on 13th December, 1890, and its origin gave rise to some discussion; so as the acid in many of the cells at the Post Office was pink, I tested it by concentrating it down, neutralising with sodium carbonate, and then igniting on platinum foil, and always got the characteristic green of manganese.

However, lest the manganese should have come from some other source than the pink acid. I compared the absorption spectrum of the acid with that of a solution of potassium permanganate of the same shade of pink, and found they both gave the characteristic bands in the green, Fig. 14. I also found that, using two strips of platinum as electrodes in a solution of manganous sulphate, or any two strips of lead in dilute acid, gave the same colour and the same absorption bands, provided the electrodes were sufficiently far apart to prevent reduction by the hydrogen evolved by the negative. This result was important, for it is well known that the pink colour disappears from the acid in a short time if it is taken from the cell, and as persulphuric acid has no action on permanganate, but hydrogen dioxide decolourises it, this disappearance of the colour shows that the latter is formed.

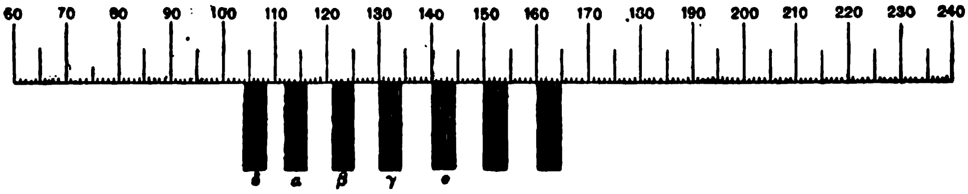

FIG. 14.—Absorption Spectrum of Potassium Permanganate.

The Effect of Hydrogen Dioxide on the E.M.F. of a Cell.—The presence of hydrogen dioxide having been thus proved, both directly and indirectly, its effect on the E.M.F. of the cell was tested. This was done by using strips of lead packed tight into small porous pots, with peroxide of lead to represent the peroxide plates, and using plain strips as the lead plates. A solution of pure sulphuric acid, density 1,180, was used as the electrolyte. The E.M.F. of the couple was taken by the deflection method, and then a drop or two of hydrogen dioxide was added to the acid, which produced a great diminution, or even reversal, of the E.M.F.

The effect of introducing hydrogen dioxide into the body of the peroxide paste was also tried, with a view of reproducing, if possible, the conditions of a cell which is started discharging directly the charge is completed, and in which the "active oxygen" would be accumulated at the positive plate, leaving the lead plate free, and I found that there was a slight increase in E.M.F.

Thus the variations in E.M.F. appear to depend on which plate hydrogen dioxide is formed at. When present at the peroxide plate it causes a rise, but when diffused through the acid and present at the lead plate it causes a lowering of the E.M.F.; and the rise in E.M.F., sometimes noticed on starting the discharge of a cell which has been at rest (mentioned in Prof. Ayrton's paper, J.I.E.E., 1890, p. 572), is probably due to the electrolysis and decomposition of hydrogen dioxide, for, in a cell which has been long idle, practically the whole of the "active oxygen" is due to this body.

CONCLUSIONS.

From the same faults appearing in batteries of such different construction, and judging also from the results of the experiments recorded in this paper, it would appear that the troubles occurring in batteries are due rather to causes arising in the working than in the manufacture. What is required is some substance which can be added to the acid to check the formation of the oxidised bodies in it, which cause sulphating without at the same time injuring the plates in other ways.

Nearly all the "forming" baths which have been introduced are baths in which hydrogen dioxide would be broken up as soon as formed, and perhaps in some modification of them the electrolyte of the future will be found; though, since the products of the electrolysis of sulphuric acid vary with the strength of the acid and the current density, no hard and fast rule can be laid down for the treatment of cells.

In cells containing acid below density 1,200, in which the proportion of "active oxygen" existing as hydrogen dioxide is high, the addition of 1 per cent. of sodium sulphate, or similar substance, is likely to prove beneficial, particularly if the work of the cells is intermittent. As the strength of the acid is increased, however, and the conditions are more favourable to the stability of persulphuric acid, less hydrogen dioxide will be produced, and there is more chance of the alkali released from the sodium sulphate during electrolysis damaging the plates.

Also, Dr. Marshall has succeeded in preparing pure persulphuric acid, and has shown this year that it forms salts with the alkalies which are very stable; and what the effect on a cell of the formation of sodium persulphate in it would be, is quite unknown. Although the formation of peroxides in the acid does not apparently account for the great gassing and sudden loss of charge sometimes observed, still we have seen that makers are reverting to Planté's process of manufacture, or modifications of it, and we may find that in this case also he was right, and that it is to the electrolyte we must look if we wish to find the means of materially improving the lead reversible battery.

In conclusion, I must thank the firms who have assisted me in the compilation of this paper by supplying information in response to circulars sent out.

MAGNETIC RELUCTANCE.*

BY A. E. KENNELLY.

(*Concluded from page 519*).

An examination of reluctivity curves naturally suggests the question as to whether there is really a strict linear relationship between H and ρ. In other words, whether the divergences of the observation curves from geometrical straight lines can be fairly ascribed to errors of observation, allowing for the influences of residual magnetism.

First confining the enquiry to the ascending reluctivity line—that which is geometrically consequent upon Frölich's formula and also under special interpretation with Lamont's formula—the agreement of the plotted observations with a straight line between the neighbourhood of the critical H and H = 150 is often so good as to intimate the existence of a definite linear relationship. It is generally to be found, however, that beyond 150 C.G.S. units of H, the line bends downward until all hope of rectilinearity is lost. That is on the simple circuit theory of reluctance. If, however, we introduce an amendment into the definition of reluctance borrowed from the vein or polar theory, the rectilinearity appears to be nearly sustained for a much greater distance. Experimental observations of the reluc-

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* Paper read before the American Institute of Electrical Engineers, October 27, 1891.

The six scales on the roller he considered unnecessary, for only one scale was required and five other sets of figures.

The **Chairman** (Mr. A. Siemens) agreed with Mr. Trotter as to the great advance made in electrical measurement since the formation of the society. The paper now before the Institution was a proof that electrical engineering had now become a science, and he doubted whether any other profession could show such a record of progress made in so short a time.

LONDON COUNTY COUNCIL.

At the last meeting of the Council the following report was submitted by the Finance Committee relating to the proposed

Loan to the Vestry of St. Pancras:

We have acted on the permission of the Council to consider further the application from the Vestry of St. Pancras for sanction to borrow and for the loan of £60,000 for electric lighting works, to be repayable in 42 years. We reported on the cost (£62,999. 7s. 5d.) of the proposed works on the 17th November, and recommend a loan of £56,300, repayable as to certain parts in varying periods of five, eight, 15, and 30 years, such varying periods being fixed on the advice of the engineer with reference to the probable life of the work on which the expenditure would be made. Consequent on the discussion which took place at the Council on the 17th inst., we have seen a deputation from the Vestry, who have pointed out to us that the works as a whole will make up a permanent going concern, and must, whenever necessary, be renewed from time to time out of the Vestry funds, so as to be kept always in good working order. We pointed out to the deputation that the Council was, under its present powers, precluded from granting loans for works for a longer period than 30 years, except for street improvements and bridges; but while admitting this, they urged, in view of applications likely to be made by other parishes for loans to carry out similar works, that the Council should obtain statutory authority to grant loans spread over a period not exceeding 60 years. Under these circumstances, we consider that it will be better for the Council to authorise the Vestry to borrow elsewhere than from the Council £60,000, leaving open the question of the Council's advancing this sum, if parliamentary authority is obtained for a longer period than 30 years. We therefore recommend:

> (*a*) That the sanction of the Council be given under seal to the borrowing by the Vestry of St. Pancras of the sum of £60,000, towards defraying the cost of certain electric lighting works, at a rate of interest not exceeding £4 per cent. per annum, and the principal being repaid by equal annual instalments within a period of 42 years from the date of the loan.
>
> (*b*) That the Council do apply to Parliament for power to make advances for electric lighting purposes to vestries and other rating authorities within the county of London, for periods not exceeding 60 years, and that it be referred to the Parliamentary Committee to take steps to obtain the necessary statutory authority for that purpose.

Mr. Campbell said he would be the last to throw any obstruction in the way of so enterprising a parish as St. Pancras. The duty of the Council with regard to these loans was to see that posterity was not unfairly burdened, and that the present generation were not allowed to play ducks and drakes with the money of posterity. The St. Pancras Vestry deserved the greatest credit for getting the provisional order to carry out their own electric lighting. In Kensington they did the same, but the difficulties and dangers seemed to them more than they were inclined to go in for. Electric lighting, he considered, could best be provided by private companies if they were not allowed too much tether, as the gas and water companies had been. They ought to recollect that a vestry had the authority to mortgage the rates. Electric lighting was comparatively in its infancy, and in the next 10 or 15 years heaven knew what the lighting of London would be. It probably would be electricity, he thought it would; still it was not yet so well established as gas was 20 or 30 years ago. The law was exceedingly defective with regard to these loans. He hoped the efforts of St. Pancras would be successful, and that other parishes would be induced to do the same thing; but he thought it fair, honest, and right that the Council should discuss the matter fully, and that they should know what they were about before they put those burdens on the ratepayers of another generation. He moved that the report be referred back to the committee for further consideration.

Mr. John Lloyd seconded the amendment, as he objected to the Council departing from the principle which they had laid down as guiding them in making loans. In this case they would have their capital in property which would be wearing out.

Mr. Osborn supported Mr. Campbell's proposition. It seemed to him an extraordinary thing that they should take out of the rates sums of money to put up plant of very short life, and spread their repayment over 42 years. Hitherto they had taken great care in granting money to local authorities to see that there was ample security for the money. In the case now before them they had none whatever. The parish of St. Pancras was starting with considerable doubt as to the success of the project, and they ought to remember the advances in electric lighting which would involve alterations. In his opinion they ought not to go beyond 12 years, and certainly in no case ought they to go beyond 15.

Mr. Howell Williams said it was quite true that some of these works would not last 42 years, but the installation would last that time, and every possible cost of maintenance would be met out of profits.

Mr. Ford thought that in making this loan they would be advancing money certainly far in excess of the life of the security.

Mr. Clarke said he looked with alarm on the Council authorising loans for such a period on such perishable articles.

Mr. Harben said they were there to protect the rates, and not to develop these companies, and if they could by any means with safety to the rates give public authorities an equal chance they ought to do so.

Mr. Westacott reminded the Council that they were not agreeing to lend the St. Pancras Vestry the money; they were only authorising them to borrow it for a period not exceeding 42 years.

Mr. Campbell: On the security of the rates.

Mr. Westacott asked whether it was not better for the parish, its ratepayers, and consumers that the Vestry should undertake this work when they could borrow at a low rate of interest rather than that speculators should come in and by-and-by induce the Council to buy the works at a large price. He hoped the Council would encourage the Vestry of St. Pancras.

Lord Lingen, the chairman of the Finance Committee, said it was seldom that he appeared before the Council to advocate a long in preference to a short period of repayment. His own opinion was most strongly, as a rule, in favour of short periods. That doctrine had not always been readily welcomed there, and he hoped after the feeling which had been shown on that proposal the doctrine would receive more favour in future. They had told the applicants that with their present powers they could not lend to them for more than 30 years. It was impossible for the Council to shut its eyes to the fact that the example which St. Pancras set in that matter was an extremely important one. Parliament had expressed an opinion on the whole favourable—certainly not unfavourable—to the idea that the municipalities should undertake for themselves, and not leave to comparatively independent companies, such undertakings as involved the breaking up of the streets. That, on the whole, he thought was a sound policy. Supposing St. Pancras did not go into the open market to borrow this money, the only alternative was that they must go to Parliament, and he himself rather leaned to the idea that they should go to Parliament, because, if they considered the magnitude of London and the enormous importance of the lighting of it as to its being done in the most efficient and economical manner, he thought it really was a question of parliamentary magnitude. The Council, therefore, by adopting the recommendations of the committee, did not commit themselves to any very dangerous precedent.

The amendment was rejected, and the recommendation of the committee agreed to.

Overhead Wires.

The Highways Committee reported concerning overhead wires that by Section 5 of the London Overhead Wires Act, 1891, the Council is empowered to make and vary by-laws with respect to (*a*) the identification of overhead wires by registration or otherwise; (*b*) the regulation of wires; (*c*) the strength of the materials to be employed in placing, maintaining, and supporting wires; and (*d*) the removal of wires erected or placed otherwise than in accordance with such by-laws and of disused wires; and the Council may by such by-laws fix and determine the penalties to be imposed on the company or person failing to comply with any of the provisions of the Act, and continuing penalties in the event of any such offence being continued after conviction thereof. These by-laws are, however, to be of no effect until approved by the Board of Trade, which department is to prescribe to whom and in what manner notices of the intended by-laws shall be given; and it is further provided that before such by-laws are proposed to the Board for confirmation notice thereof, with copies of the intended by-laws, is to be given to the Postmaster-General. The general administration of the Act, and the enforcement of the by-laws when made by the Council and confirmed by the Board of Trade, devolve upon the local authorities—*i.e.*, within the City of London, the Commissioners of Sewers, and outside the City the vestries and district boards, except on the Victoria-embankment and the bridges, which are vested in the Council. We have prepared a series of by-laws (a copy of which has been sent to each member of the Council), and the Board of Trade has prescribed to whom and in what manner the notices of the intended by-laws shall be given. It is probable that some exception may be taken by companies and others interested to some of the provisions contained in these by-laws, and we are of opinion that we should have instructions to consider any suggested alterations and to represent the the Council before the Board of Trade. We recommend:

> That the draft by-laws under the London Overhead Wires 1891, be approved, and that it be referred to the Highways Committee to issue notices and to take all other necessary measures to obtain the confirmation of the by-laws, including, should the committee consider it advisable, the employment of counsel to support the by-laws before the Board of Trade.

The consideration of this matter was postponed.

A Dynamo to be Purchased.

With regard to meter testing, the report said: We have to report that it has been found impracticable to test with the current supplied by the Metropolitan Electric Supply Company, meters, of the pattern approved by the Board of Trade, sent in by the House-to-House Electric Light Supply Company, on account of the difference in the number of alternations used by the two companies; and that in order to overcome the difficulty it will be of £25,000 in £1 shares. Object: to carry into effect two agreements, the first, made October 15th, between William Rutton May and another, of the one part, and A. Hoster, of the other part; the second, made November 25th, between W. R. May, of the one part, and V. Laroni, on behalf of this Company, of the other part, for the acquisition of certain patents relating to improvements in electrical timepieces, and generally to work and develop the same. There shall not be less than three or more than seven Directors; the first to be appointed by the signatories to the memorandum of association. Qualification not specified. Remuneration, £500, with an additional 5 per cent. on the amounts paid by the Company in dividends, the same to be divisible.

National Telegraph Works Company, Limited.—Registered by A. P. Honeyman, 9, Bennett's-hill, Birmingham, with a capital of £5,000, in 990 £5 ordinary shares and 50 £1 founders' shares. Object: to carry into effect an agreement expressed to be made between J. S. Lewis, of the one part, and this Company of the other part, and generally to carry on business as manufacturers, merchants of, and contractors for, pressed steel, iron, or other metal, and as electrical engineers, contractors, etc. There shall not be less than two nor more than six Directors. The first are J. S. Lewis and A. H. Church, both of Birmingham. Qualification, 50 ordinary shares, or one founder's share. Remuneration to be determined by the Company in general meeting.

New Motor Syndicate, Limited.—This Company has been registered, with a capital of £5,000, in £10 shares, to adopt an agreement, dated August 12, 1891, between Mr. T. C. Hersey of the one part, Mr. William Knight of the other part, and to carry on any business which may be acquired.

CITY NOTES.

City and South London Railway.—The receipts for the week ending November 29 were £806, as against £793 for the week ending November 22.

Eastern Telegraph Company.—The receipts for November were £60,053, as against £59,975 for the same period of 1890, an increase of £1,073.

Brazilian Submarine Telegraph Company.—A quarterly interim distribution of 3s. per share is announced by the Company, payable on the 21st inst.

Eastern Extension Telegraph Company.—The receipts for November amounted to £40,686, as against £44,742 in the corresponding period, showing a decrease of £4,056.

Shippey Bros., Limited.—We are informed that the entire block of shares in the above Company recently placed on the market has been purchased by Messrs. Gwynne and Co., engineers, of Essex-street, Victoria-embankment, E.C.

Pilsen Company.—We learn that the Pilsen Electric Company have secured an exclusive license from the proprietors of the C. & C. motor patents to manufacture and supply the well-known Curtis, Crocker, and Wheeler electric motors, electric pumps, blowers, etc., both for England and France, and that the Pilsen Electric Company, whose business has recently been removed from Stanhope-street to larger and more complete works, 80, Leather-lane and Baldwin's-gardens, Holborn, intend to vigorously push the Crocker-Wheeler systems throughout the United Kingdom.

PROVISIONAL PATENTS, 1891.

NOVEMBER 23.

20312. **Improvements in the form of electrical battery cells, boxes, or other vessels.** John Miles Moffat, 100, Victoria-street, Westminster, London.

20314. **Electrical thermometer.** James Gratton, 3, Peel-terrace, Peel-street, Nottingham.

20328. **Improvements in producing alternating currents differing in phase.** Rankin Kennedy, Carntyne Electric Works, Shettleston, Glasgow.

20356. **Improvements connected with electric arc lamps.** Webster Storr, 166, Fleet-street, London.

NOVEMBER 24.

20367. **Improvements in couplings for electric wires.** Alexander Shiels, 70, Wellington-street, Glasgow.

20389. **Magnetic microphone.** Edward Turner Whitelow, 70, Deansgate, Manchester.

20413. **Improved electrolytic apparatus, more particularly for manufacturing caustic soda and other products from salt, but also applicable to other purposes.** Godfrey Bamberg, 28, Southampton-buildings, London.

20416. **Improvements in apparatus for separating magnetic ore from sand.** Francis James Bell and Walter Bassett Basset, 28, Southampton-buildings, London.

NOVEMBER 25.

20485. **Improvements in automatic safety devices for electric circuits.** Frank Bryan, 11, Brackley-terrace, Chiswick, London. (Complete specification.)

20492. **Regulating electric currents.** Leslie B. Miller and Maurice W. Woods, 34, Gray's-inn-road, London.

20496. **Electrical switch.** Alfred Champion and James N[illegible], 112, Shardeloes-road, New Cross, London.

20506. **Improvements in microphone transmitters.** Sir C[illegible]les Stewart Forbes, Bart., 21, Finsbury-pavement, Lon[illegible].

20508. **Improvements in and relating to dynamo-[illegible]tric machines.** Thomas Henry Williams, 70, Chan[illegible]-lane, London.

20530. **Improvements in and relating to ship telegraphs.** Albert Barthold Wilhelm Henry Cords, 46, Lincoln's-inn-fields, London.

NOVEMBER 26.

20542. **Improved incandescent lampholder and form or shape of incandescent lamps.** Thomas John Rickard, Beaconsfield Cottage, Sebastopol, Newport, Monmouthshire.

20545. **An improved system of telephonic exchange signalling.** Alfred Rosling Bennett and Robert McLean, 22, St. Albans-road, Harlesden, London.

20595. **Improvements in arc lamps.** Frederick Richard Boardman, 433, Strand, London.

20604. **Improvements in electric motors or generators.** Henry Harris Lake, 45, Southampton-buildings, London. (William Stanley, jun., and John Forest Kelly, United States.) (Complete specification.)

NOVEMBER 27.

20623. **Improvements in telephone transmitters.** William Maxwell, 34, Claybrook-road, Fulham, London.

20629. **Improvements in holders for incandescent electric lamps.** Charles Mark Dorman and Reginald Arthur Smith, 24, Brasenose-street, Manchester. (Complete specification.)

20678. **Improvements in electric burglar alarms.** Franz Pohl, jun., 18, Buckingham-street, London. (Complete specification.)

20689. **Improved cementitious and electric insulating compounds.** Murdoch Mackay, 166, Fleet-street, London.

20699. **A new or improved electric indicator.** Harold William Thatcher and Arthur Devereux, 22, Glasshouse-street, London.

NOVEMBER 28.

20718. **Magnetic electric boot and shoe (iron and steel) grindery.** Percival Pickney, 151, Somers-road, Southsea, Hants.

20748. **Treatment of and production of valuable products from sludge obtained by electrical treatment of sewage.** Frank Scudder, 46, Lincoln's-inn-fields, London.

20799. **Improvements relating to electric call systems and apparatus for use therein.** William Hamilton Blakeney, 45, Southampton-buildings, London.

SPECIFICATIONS PUBLISHED.

1890.

17863. **Electric lamps.** Hardt. 8d.
18555. **Electrical switches.** Pierce. 6d.
18557. **Electrical switches.** Pierce. 6d.
18558. **Electrical pendants, etc.** Pierce. 8d.
20102. **Dynamo-electric machines.** Baxendale. 6d.
20896. **Regulating electric currents.** Gay and Hammond. 11d.

1891.

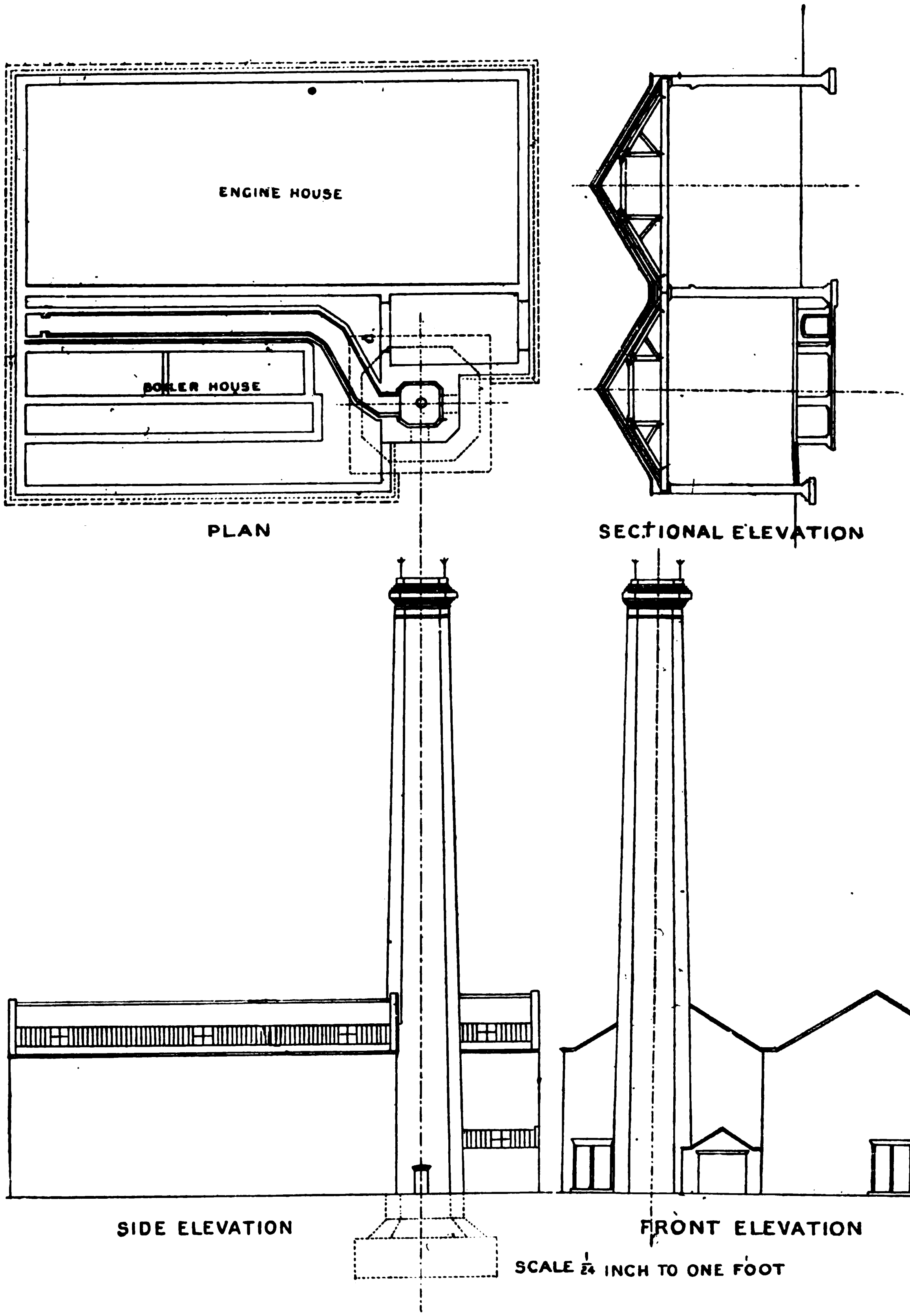
40. **Electricity meters.** Hookham. 8d.
200. **Electric arc lamps.** Brianne. 8d.
271. **Electric arc lamps.** Schoenerstedt. 8d.
617. **Electric arc lamps.** Allison. (Ward.) 11d.
5043. **Arc lamps.** Money and Nash. 11d.
10239. **Railway electrical block systems.** Guiley. 8d.
12322. **Electrical welding.** Boult. (Bassle.) 8d.
16487. **Primary batteries.** Leigh. (Gardiner.) 6d.
16989. **Printing telegraphs.** Lake. (Farmer.) 8d.
17003. **Secondary batteries.** Madden. 11d.

COMPANIES' STOCK AND SHARE LIST.

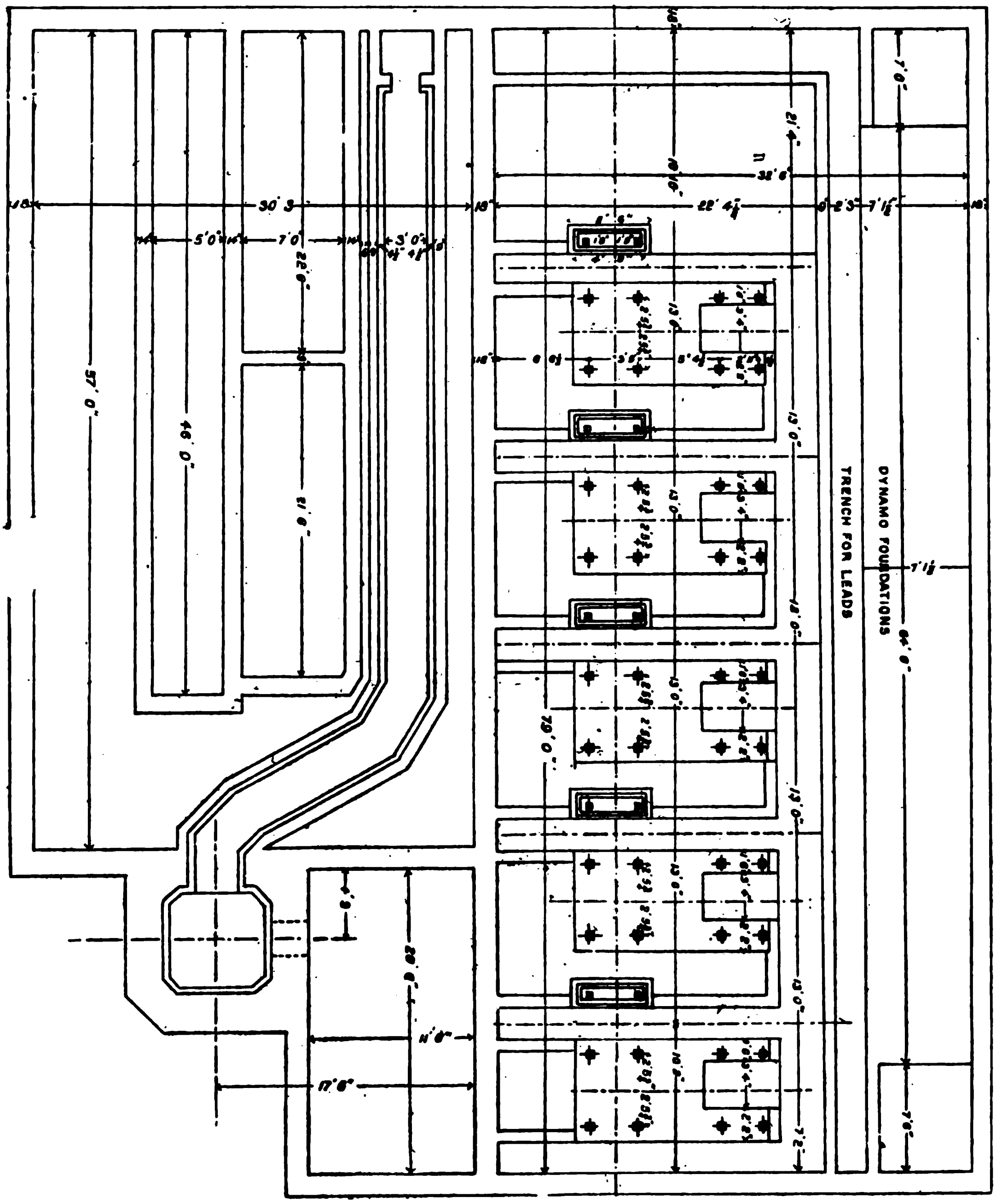
Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2¼
India Rubber, Gutta Percha & Telegraph Co.	10	19½
House-to-House	5	5
Metropolitan Electric Supply	—	10⅜
London Electric Supply	5	1⅞
Swan United	3½	4¾
St. James'	—	8⅞
National Telephone	5	4⅜
Electric Construction	10	7
Westminster Electric	—	6⅝
Liverpool Electric Supply	5 3	5⅛ 2⅞

THE SYDENHAM ELECTRIC LIGHT STATION.

In our issue of October 23 we recorded the laying of the foundation-stone of a new central station for the Sydenham district. The station is being built and fitted by Messrs. J. E. H. Gordon and Co., to the order of the Construction and Maintenance Company. Our most recent visit to the works was on Saturday last, when Mr. Todd, who is actively superintending the due execution of the work, explained what had been done and what remained to be done. There is little doubt [illegible] station will be ready to supply current at the opening of the Crystal Palace Exhibition on January 1st, 1892. Three boilers were in position, and a fourth was at the door, the fifth being at the railway station, so that before the time this notice appears in type the five boilers will be in position, and three of them ready for steaming, as will be at least two engines. The time has come, therefore, when a complete description of this new station may be given. In our issue of to-day we commence the necessary illustrations for such a description. These will be

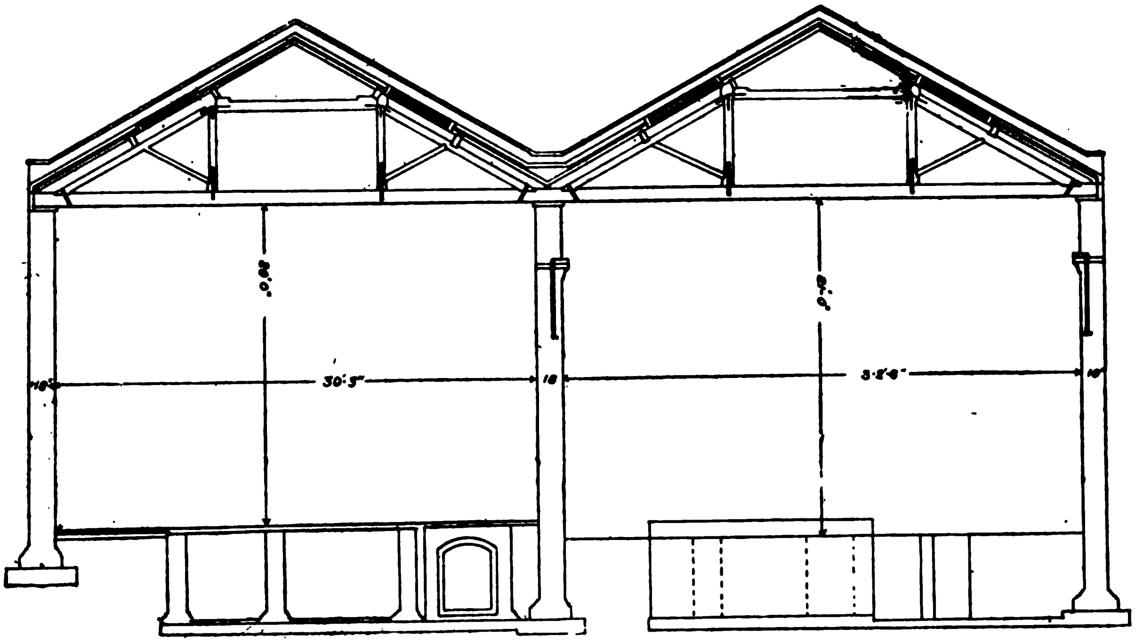


Sydenham Electric Light Station.



Scale 3/16 in. to one foot.

SYDENHAM ELECTRIC LIGHT STATION.—GENERAL PLAN OF FOUNDATIONS.



followed from week to week till the whole have been presented to our readers, who will then have the most complete record of any central station that has ever been given.

leading out from this—namely, that we will be able to use alternating currents for operating our street cars, for it is well known that the ordinary alternating-current generators will operate perfectly as motors, if the speed and torque be kept constant. Since by this system we can, from a constant torque and speed, get any other torque and, automatically, a corresponding speed, we shall be able to run street cars perfectly by alternating currents. This, again, will enable us to dispense with trolleys, conduits, storage batteries, etc. We will place between our tracks, in manholes, converters whose primary pressure can be anything required for proper economy and whose secondary will be, say, 15 volts. This secondary circuit will connect directly with the rails. The road will be divided in sections, each a few hundred feet long, and each section will be supplied by its own converter.

This system also lends itself very readily to the transmission of power. We may transmit by alternating currents, and the alternating-current motor running at a constant speed and at a nearly constant torque will drive special generators to operate hoists, pumps, locomotives, etc., at the varying torques and speeds demanded by practice, and yet without subjecting the alternating-current motor to a sudden or wide fluctuation in its torque and without any necessity of varying its speed. With this system of operating electric motors there seems to be no work met with in practice which cannot be perfectly performed.

On first consideration, the additional apparatus necessary would seem to make the system prohibitory in practice; but the capacity of the present single motor is greater than the combined capacity of the apparatus this system would require, and the capacity of the prime motor is very much reduced.

In order to reduce the first cost to a minimum and yet secure the advantages of different automatic speeds and high efficiency, I have devised two modifications of the arrangement described above. The first is adapted to power in which a smooth, efficient acceleration of a load from rest is required, as in the case of passenger locomotives and elevators. The second case is where various automatic speeds are desired, but no especial importance attaches to the starting of the load from rest, as is the case in machinery in general.

For the first case we have the trolley system of electric street cars as the most important. Let us suppose we have two motors of 15 h.p. each for the car. We find that for full speed upon a level we require about 15 amperes at 500 volts. Upon heavy grades we find that about 50 amperes are required, and, as before, we have 500 volts. With this consumption of energy we find that we get a speed upon the heavy grade which is about one-quarter of the speed upon a level. In order to operate upon my system, let us place upon the car a motor generator, the motor part of which is wound for 500 volts and 12½ amperes and the generator part of which is wound for 125 volts and 50 amperes. The fields of the motor and generator part are distinct, and are wound for 500 volts, as are the fields of the two propelling motors under the car. All these fields are supplied from the 500-volt trolley circuit. In the field of the auxiliary generator is placed a rheostat.

Now, suppose the car at rest upon a grade. The motor generator is running, but the generator has a very weak field. Its armature is connected by a controlling switch to the propelling motors. We now gradually cut out resistance from the generator field circuit, and finally get about 20 volts at the brushes of the generator. With this E.M.F. we get sufficient current to produce 50 amperes through the armatures of the propelling motors in a saturated field. This gives us the full torque, and the car starts at a speed of perhaps half a foot a second. This speed can be maintained constantly and indefinitely, and the consumption of energy will be less than 2 h.p. This is less than three amperes from the trolley line. In practice, however, the ed will be rapidly but gradually accelerated, until we 125 volts upon the terminals of the propelling motors. ticill now be running at one-quarter speed, and will be be peg 125 volts and 50 amperes—that is, 6¼ kilowatts sacrific25 kilowatts to get the same result with existing put it another way, we will not be using as much energy as is represented by the 500 volts and 15 amperes necessary for full speed on a level.

The next step on the controlling switch will disconnect the armatures of the propelling motors from the auxiliary generator and put the two armatures in series across the trolley line direct. We will now go at a speed represented by 250 volts—that is, one-half full speed. The next step of our switch will place the two armatures in multiple across the 500 volts, and the next and last step will place the 120-volt auxiliary generator in series with the main central station generators, and give us 625 volts on our armatures and a correspondingly increased speed. We will be able to go up a grade of 6 to 8 per cent. at full speed, with 50 amperes and 500 volts, which, with the present motors, gives only about one-quarter of that speed.

Under this arrangement it will be noticed that the only apparatus which could be called additional is the small motor of 500 volts for the generator part of our motor generator, which is useful, not only for starting, but for full speed also. In stopping the car we have an electric brake action delivering back energy to the line at full efficiency and not through a rheostat, as at present.

If we have a train of, say three cars, so that we have six motors, we can start from rest with sufficient smoothness by placing all six armatures in series, which will give us something less than one-sixth speed as the first step. Then we can place three in series with two multiples, which gives us one-third speed. Next, two in series with three multiples, which gives us one-half speed; and finally, all in multiple, which gives us full speed. Under such conditions, we can dispense with the small converting plant altogether.

For an elevator requiring, say, 15 h.p. we will put in a motor generator of 3 h.p., with which we will control the starting and stopping and the operation up to one-fifth of full speed. Then for full speed we will connect direct to the line and operate without any conversion of energy.

For power in which smoothness of motion in starting and stopping is not essential I have devised a new system of distribution, as follows: three dynamos all having the same current capacity and having voltages of 62½, 125, and 250 respectively, are placed in series and from conductors led off in multiple, one from each terminal of the machines. These conductors will have potentials which can be represented by 0, 62½, 187½, and 437½. Let us now take a shunt-wound motor, and, disconnecting the field from the armature circuit, excite the field from the outside two of the four conductors, that is, by an E.M.F. of 437½ volts. By connecting the armature terminals to the four conductors in various ways we shall be able to operate in either direction at six different automatic speeds represented by the following voltages: 62½, 125, 187½, 250, 275, 437½. By varying the field strength of the motor we can, if required, get any intermediate speed.

In many cases two dynamos will answer, one of, say, 110 volts already in use for incandescent lighting, and a second of, say, 30 volts. With this arrangement we could run in either direction and with automatic speeds represented by 30, 110, and 140.

With the four-wire six-voltage system of distribution in a shop we can take out all countershafting, belting, pulleys, and gears, if desired, and place a motor upon every tool, which we can operate in either direction at any automatic speed desired. Lathes, planers, and all tools can be perfectly operated, and by getting rid of all countershafts and belts we can introduce the greatest of modern tools, the travelling crane, which we will also operate from our general system. We can also readily operate ventilating fans, hoists, elevators, and factory tramways from the system.

The addition of one dynamo and one new conductor to any existing three-wire system will probably give all the flexibility required to meet practical conditions of varying speeds. For the alternating system a synchronous motor driving our three continuous-current generators will give us the four-wire system in any distant factory or town. For 500-volt street railway circuits a small motor generator plant for the slow speeds and a direct connection for full speeds will give us perfect results. For storage battery work we have the most perfect condition, as we can get

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* "Elect

The streets comprised in the compulsory area are at present lighted by means of the following lamps—viz.:

	£	s.	d.		£	s.	d.
Three 150-c.p. lamps at	12	10	0	...	37	10	0
One 150-c.p. „ „	13	5	0	...	13	5	0
Seventy 100-c.p. „ „	6	17	6	...	481	5	0
One 100-c.p. „ „	7	10	0	...	7	10	0
Five 50-c.p. „ „	6	0	0	...	30	0	0
Twenty-nine 16-c.p. ordinary street lamps	2	16	0	...	81	4	0
Total cost per annum					£650	14	0

To light the same streets partly by electricity and partly by gas, in the manner recommended by the sub committee, the borough engineer estimates the cost as follows:

	£	s.	d.	£	s.	d.
Sixty electric arc lamps, burning from sunset to midnight at	12	0	0	720	0	0
Eighty-two ordinary street lamps burning from midnight to dawn at present rate of prices, at	1	18	3	156	16	6
Twelve ordinary lamps burning from sunset to dawn as at present, at	2	16	0	33	12	0
Two 100-c.p. lamps burning as at present, at	6	17	6	13	15	0
One 150-c.p. lamp burning as at present ...		—		12	10	0
Two 50-c.p. lamps burning as at present, at	6	0	0	12	0	0
Estimated cost per annum				£948	13	6

W. HARPUR, Borough Engineer.

THE ELECTRIC LIGHTING OF SYDNEY.

LECTURE BY PROFESSOR THRELFALL.

The remarks on the subject of electric lighting of Sydney which I have the honour of making, are addressed neither to the expert electric engineer nor to the person who is wholly without information regarding electrical matters. Anyone at the age of 20, or over, who is without a rough idea of the *modus operandi* of a steam engine would be generally considered to be an ill-educated person, and exactly the same criticism is applicable to any member of the rising generation who is ignorant of the general principles of the machines by which electric currents are produced. I shall assume, therefore, that those who are kind enough to come here to listen to me are possessed of this element of education. If I were addressing you on some point in classical archæology you would probably consider that you ought to feel hurt and insulted if I prefaced my remarks by a *résumé* of Greek or Roman mythology; and I believe the time has now come when a man ought to feel still more insulted by the implication that he is ignorant of the principles of a dynamo machine or incandescent lamp. I say this after full consideration, and with the knowledge acquired after five years' experience of the public examinations, that general elementary information with regard to physical phenomena is at a lower ebb in this colony than in Queensland, or, I believe, in any other corner of the globe. The problem we have to face to-night has little to do with the generation of electric energy, or with its conversion into light in the lamps. We are solely concerned with a consideration of the best way of getting the electric energy generated in the stations up to the lamps. We may hope for some improvement in our engines, and an almost indefinite improvement in our lamps, but the dynamo of to-day is nearly a perfect machine, in which only a very insignificant amount of improvement is possible. The great problem is how to get the energy to the lamps most economically. Before I go on to describe in detail the arrangements which have been proposed to the City Council by Colonel Cracknell and myself, I must clear the way by some preliminary statement of the conditions to be fulfilled. At present we may say that there are only two classes of lamps in the market—the incandescent and arc lamp. The former is much less economical than the latter where great illumination is required, and consequently we have recommended that the streets marked red in the map before you be lighted by arc lamps. Now it so happens that lighting by arc lamps is the most simple and straightforward job the electrical engineer ever has to face, because it is not complicated by any great difficulty in designing an economical conductor. An average arc lamp takes about 10 amperes with 50 volts, or uses about 500 watts; or taking losses into account, the engines in an electric light station must develop nearly a horse-power per arc lamp. Such a lamp gives an illumination of rather less than 1,000 standard candles, and for some strange and obscure reason is often described as a 2,000-c.p. lamp. Now, the conductor necessary to transmit the current along a row of these lamps in series is not very big, for the current required is small, and may be reckoned at, say, £60 per mile. We propose to employ 431 arc lamps, which will require about 52½ miles of wire, costing about £3,150—a small sum compared with the rest of the proposed expenditure for street lighting, which is about £103,000. The only difficulty and considerable expense lies in providing proper conduits for the wires, but of this more presently. Our difficulties begin when we come to the installation for private lighting; for the street incandescent lamps are worked in a manner similar to the arc light, and cause no trouble. The trouble is this, that it is very difficult to arrange both the lamps and wires so that the brightness of the lamps to any given house shall be independent of the number of lamps which may happen to be in use at the time. It is by no means an easy matter to design a system so that the lamps all over a district shall be equally bright, whatever may be the number of lamps alight, or however their distribution may vary. We must add to this the necessity of providing for extension cheaply and speedily to meet new business, and this without interfering with the general conditions of supply, so that the problem becomes still more complicated. Happily, however, for us, the people of more progressive countries than ours have accumulated a considerable stock of experience, not so much as to what ought to be done as to what should be left undone. I have here a curious zigzag curve, which is called a load curve, and shows how the number of lamps varied during one day at a particular station in London. It does not profess to be an average curve; I took it merely because it was the first I happened to come across, and it will serve perfectly well. By following out the curve you will be able to form an idea of the habits of the people using the light. For instance, in this case the average time for breakfast is clearly 8; and hardly anybody gets up before 6, or goes to bed after 1. At 6 o'clock in the afternoon the shops are still open, and some people are having dinner. At 8 o'clock more shops are shut and people are finishing dinner, for the lights begin to go out very quickly, and continue to do so up to 1 o'clock. The first duty of an electrical engineer in designing the private lighting of a town is to attempt to construct a load diagram from the known habits of the people. He has, in fact, to conduct a statistical enquiry. I have spent a considerable time in wandering about the streets in the evening to see how the shops closed, and also in observing the relative number of people in the streets at different hours of the evening. I prophesy that the Sydney load curve will differ considerably from the curve marked in blue (which is, of course, a London December curve). My guess is embodied in the curve shown. Having settled on the most probable form of load curve, the next point in the investigation is to decide on the proper number of lamps for which provision should be made. At best the result will only be a guess, but we may guide ourselves to some extent by experience in other towns. The most important lesson we can learn is that the use of electric light is invariably rapidly increased after the means of supplying it have become known and relied on. Consequently we may be sure that so long as we do not attempt to force an outrageous number of lamps on the consumer, we are practically certain sooner or later to be able to dispose of all our electricity. The question therefore becomes simplified to the following: At what point in making provision for future requirements will the capitalised interest on fixed capital become equal to the extra outlay required in extension. For instance, suppose we have a district in which we discover by a canvass that 10,000 lamps will be immediately absorbed with a prospect, say, of 50,000 in five years' time. The question is, how far will it pay us to go in providing for the future from the very commencement? Ought we to provide for 20,000 or 30,000 lamps; or will it pay simply to provide for the immediate requirements and allow the future to look after itself? Now when we have to deal with underground modes of distribution the expense of pulling-up and laying down footways is pretty much the same, however often it has been done, and we may regard extension of existing conductors, whether in weight or length, as very nearly as expensive a process as the first laying, consequently I say wherever it is intended to employ an underground system it will be sound financial policy to lay mains of several times the capacity of the immediate demand. I consider that if the cables are continuously insulated it will pay to put them down for about three times the actual demand, but if they are of bare copper everything will depend on the details of the system. Now, by taking the number of houses in the various districts of Sydney, and making liberal use of the imagination, Colonel Cracknell and I have arrived at the conclusion that we might begin by making provision for the simultaneous supply of electricity to 10,000 lamps. This means that we may allow our customers to wire, say, 14,000 lamps, because experience shows that at the very most there are never more than 70 per cent. of lamps in use at once. This is particularly the case if current is charged for by meter, because people are careful to turn out the lamps they don't want, and so reap one of the chief benefits of electric lighting; whereas, if the lamps are paid for by assessment of so much per lamp per annum, people are wasteful under the impression that they are getting their money's worth. No idea could be more fallacious. If a thing is wasted it is gone, and somebody has to pay for it. The somebody is, of course, the consumer himself in the long run, both directly in that he has to pay a higher rate than he otherwise need; and indirectly in that the high price keeps other people out of the system. Supply by meter is, in fact, an essential feature of a good system; and the electric meter is not likely to follow the gas meter in gaining a again be at the maximum of £120,000. The outstanding bonds will thereby be reduced to £200,000.

The Eastern Telegraph Company announce the payment on January 14 of interest at the rate of 3s. per share, less income tax, being 6 per cent. per annum on the preference shares for the quarter ending December 31; and the usual interim dividend of 2s. 6d. per share on the ordinary shares, tax free, in respect of profits for the quarter ending September 30.

Companies of the Month.—The following electrical companies have been registered during the past month:

Bicester Electricity Supply Company, Limited, £5 shares	£5,000
Connelly Motor Company, Limited, £1 shares	70,000
Electrical Finance Corporation, Limited, £5 shares	100,000
Globe Electric Company, Limited, £1 shares	10,000
Isle of Wight Electric Lighting Company, Limited, £1 shares	1,000
International Electric Subway Company, Limited, £1 shares	25,000
Johannesburg Lighting Company, Limited, £1 shares	150,000
New Motor Syndicate, Limited, £10 shares	5,000
National Telegraph Works Company, Limited, £5 and £1 shares	5,000
Patent Electromagnetic Clock Syndicate, Limited, £1 shares	25,000
Railway Electrical Fog Signal Syndicate, Limited, £1 shares	25,000

PROVISIONAL PATENTS, 1891.

NOVEMBER 30.

20807. **An automatic electric disc vote recording and counting machine.** Walter Hearn and William Frederick Lewis, 11, Queen Victoria-street, London.

20814. **Simultaneous telegraphy and telephony.** John Morgan Richards and Johnston Stephen, 46, Holborn-viaduct, London.

0825. **Improvements in the insulating or covering of or for electrical cables.** Henry Edmunds and George Edward Preece, 47, Lincoln's-inn-fields, London.

20827. **Improvements in electric lighting attachments for gas burners.** David James Quinn and Paul Walter Hoffmann, 55, Chancery-lane, London.

20830. **Improvements in electric safety lamps for mining and other purposes.** Ernst Böhm and Ernest Bailey, 57, Cheapside, London.

20837. **Extracting gold and silver from sea-water by electrolysis.** Charles Hyatt Woolf, Arthur Eugene Hayman, and Alexander Denon Rushton Jameson, 78, Fleet-street, London.

20840. **Improvements in armatures of dynamo-electric machines.** John Nebel, 28, Southampton-buildings, London. (Complete specification.)

20864. **A new or improved combined electro-medical apparatus coil and battery.** Thomas Clement Hodgkinson and Henry Thomas Tompsitt, 23, Southampton-buildings, London. (Complete specification.)

20865. **An improved electric railway system.** Alexander James Eli, 76, Chancery-lane, London. (James Slough Zerbe, United States.)

DECEMBER 1.

20886. **Improvements in or connected with electric masthead and side lights for ships.** William Crammond Martin and John Hunter, 87, St. Vincent-street, Glasgow.

20900. **Improvements in arc electric lamps.** William Macpherson, 11, Furnival-street, London.

20913. **Improvements in electrically-propelled vehicles.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20922. **Improvements in storage batteries or accumulators.** Carl Lütcke, 6, Lord-street, Liverpool.

20924. **Improvements in and relating to electric fire engines.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20930. **Improvements in electrically-propelled vehicles.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20933. **Improvements in and relating to electrically-propelled hose carts or carriages.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20936. **Improvements in electric heating apparatus.** Mark Wesley Dewey, 45, Southampton-buildings, London. (Complete specification.)

20969. **Improvements in electrolytic tanks.** Trevenen James Holland, 6, Bream's-buildings, Chancery-lane, London.

20970. **Improvements in apparatus for measuring and registering electric currents.** James William Thomas Cadett, 33, Southampton-buildings, London.

20972. **Improvements in combined haulage and electric cables.** George J. May, 22, [illegible]hampton-buildings, London.

[illegible] 2.

21018. **I[illegible]ts in th[illegible]nction of electric[illegible]lly-cont[illegible] lamps.** [illegible] Thomas Schr[illegible], Sunb[illegible], Bradf[illegible]ire.

21028. **An improved gas or electric light appliance attached to a stud for the purpose of illuminating a dress shirt-front.** Walter Walton and Ernest Lester, 16, Knox-road, Clapham Junction, London.

21033. **Improvements in dynamo machines.** Lazarus Pyke and Edward Stephen Harris, 433, Strand, London.

21034. **Improvements in musical instruments operated by electricity.** Paris Eugene Singer, 6, Victoria-road, Kensington, London.

DECEMBER 4.

21142. **Improvements in ceiling roses for electrical fittings.** Walter Poynter Adams, Springwell, Barnes, Surrey.

21143. **Improvements in electrical cut-outs.** Walter Poynter Adams, Springwell, Barnes, Surrey.

21154. **Improvements relating to electrical lampholders.** Charles Scott Snell and Woodhouse and Rawson United, Limited, 88, Queen Victoria-street, London.

21173. **Means and electrical apparatus for promoting the growth of bulbs and other plants.** Robert Henelade Courtenay, 6, Pennsbury-terrace, Wandsworth-road, Surrey.

21187. **Improvements in regulating steam engines working dynamo-electric machines and apparatus for that purpose.** Peter Valentine McMahon, 28, Southampton-buildings, London.

21207. **An improved electromotor.** Thomas Sturgeon, 8, Quality-court, London.

21211. **An improved electric call system and apparatus for use in connection therewith.** William Hamilton Blankeney, 45, Southampton-buildings, London.

21214. **Improvements in meters or recorders of electricity.** Alfred Julius Boult, 323, High Holborn, London. (Claude Lebois, ——.)

DECEMBER 5.

21245. **Certain improvements in electric alarm and call clocks.** Joseph Louis Clerc, Jean Picard, and Iréné Rougeant, 64, Mark-lane, London.

21246. **Improvements in compound winding of groups of dynamos.** John Macintosh Mackay Munro, 154, St. Vincent-street, Glasgow.

21259. **Improvements connected with cash tills and means for electrically indicating each opening of the same as a check to the receipts.** Albert Samuel, Ernest Samuel, Thomas Furze, and Frank Simmonds, 166, Fleet-street, London.

21265. **A new or improved coin-freed device for operating electric circuits.** Henry Hutchins Brown, Anders Elliott, and Chetham-Strode, Limited, 4, Moorfields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1885.

9527. **Electric railways.** Handford. 8d. (Second edition.)

1890.

18554. **Electrical conductors.** Pierce. 8d.

19308. **Electrical distribution of power by alternating currents.** Swinburne. 8d.

20379. **Electric conduit.** Bayly. (Loth.) 8d.

1891.

258. **Electric arc lamps.** Gay and Hammond. 8d.

389. **Electricity meters.** Teague. 8d.

587. **Incandescent electric lamps.** Berlyn. 8d.

6773. **Signalling time, etc., by electricity.** Von Orth. 8d.

13553. **Electrically-heated ovens.** Mitchell. 6d.

16099. **Converting electrical energy of alternating currents.** Bradley and others. 8d.

17291. **Electric soldering irons.** Mitchell. 6d.

17406. **Arc electric lamps.** Todman and Angold. 6d.

17430. **Electric batteries.** Lamb. 8d

17454. **Electric conductors.** Threlfall. 6d.

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Metropolitan Electric Supply	—	10⅛
London Electric Supply	5	1⅜
Swan United	3⅛	4¾
St. James'	—	8⅞
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Electric Construction	10	5½
Westminster Electric	—	6⅝
Liverpool Electric Supply	5 3	5⅛ 2⅞

ON THE SPECIFICATION OF INSULATED CONDUCTORS FOR ELECTRIC LIGHTING AND OTHER PURPOSES.*

BY W. H. PREECE, F.R.S., PAST-PRESIDENT.

(Concluded from page 567.)

The practical standard, then, of specific insulation which I propose to adopt is the resistance of an earth-quadrant (1,000,000,000 centimetres) cube of a certain insulating material which at 0deg. C. gives a resistance of one megohm. In this sense the specific insulations, σ, of various materials, calculated from dimensions and resistances, but not corrected for temperature, are as follows:

Material.	C.G.S. units.	Proposed standard.	Temp. deg.C.	Authority.
Air	∞	∞		
Mica	$8{\cdot}4 \times 10^{22}$	·084	20	Ayrton and Perry.
Guttapercha	$4{\cdot}5 \times 10^{23}$	·45	24	L. Clark.
Indiarubber	$1{\cdot}09 \times 10^{25}$	10·9	24	Jenkins
Shellac	$9{\cdot}0 \times 10^{24}$	9	28	Ayrton and Perry.
Hoopers' core	$1{\cdot}5 \times 10^{25}$	15	24	Tests.
Ebonite	$2{\cdot}8 \times 10^{25}$	28	46	Ayrton and Perry.
Paraffin	$3{\cdot}4 \times 10^{25}$	34	46	„ „
Glass (flint)	2×10^{25}	20	20	T. Gray.
Siemens's special high insulating rubber		16·17	15	
Siemens's ordinary pure and vulcanised rubber		2·28	15	
Siemens's specially high insulating fibrous material		11·90	15	
Fowler-Waring dielectric		7·33	15	
Glover vulcanised rubber		1·63	15	

To obtain the true value for σ these results, of course, ought to be corrected to 0deg. C.

ELECTRIFICATION.

Insulated conductors should always be subjected to the process of electrification for one minute before the scale reading from which the insulation is to be calculated is noted. The leakage current polarises the dielectric; the insulation apparently improves—rapidly at first, then more slowly—and unless some conventional time was agreed upon for the test, proper comparison could not be made. One minute is universally accepted as the period. The rate of fall due to electrification is a great test of the quality of the insulating material. It varies with the nature and quality of the material, being more marked at low temperatures. Unsteady electrification is a sign of an incipient fault, and perfectly regular electrification is an indication of good material. The resistance of the dielectric apparently gradually increases, owing to the formation of an opposing E.M.F. in what is probably a liquid electrolyte. As the rate at which electrification proceeds is an uncertain quantity, and in the best material is very low, it is better to specify that the electrification shall progress steadily, without stating the rate at which it proceeds. The temperature at which the test is to be made should also, of course, be given, 75deg. being the usual standard.

THICKNESS OF INSULATION.

More important is it to determine and specify the thickness of the insulating coating. Two conditions determine this—the E.M.F. to be used and the mechanical conditions of manufacture. We have also to consider sparking distances in air, especially in the case of high-pressure mains, when heat, age, accident, and use cause decay and cracks, and the conductor becomes exposed through fissures. I cannot contemplate a less thickness of any material than 1 mm., or ·04 of an inch, for a No. 19 wire. That means that a millimetre conductor requires as a minimum a millimetre thickness of insulating coating. Now the striking distance of a millimetre in air is over 600 volts. As the conductor increases in diameter the thickness must increase in greater ratio, not because the E.M.F. requires it, but because the exigencies of manufacture and the mechanical construction of the core demand more stuff to resist the stresses brought to bear upon it. Given a conductor with a certain thickness of dielectric able to resist the stress of x volts, the same thickness will equally resist the same voltage whatever the diameter or sectional area of the conductor.

The actual thickness to be used above the crucial thickness required for the security of those who accidentally or purposely handle the wire is a manufacturer's question; the engineer can specify only the minimum thickness. The Board of Trade rule for aerial conductors is the following:

"Every high-pressure aerial conductor shall be continuously insulated with a durable and efficient material, to be approved by the Board of Trade, to a thickness of not less than one-tenth part of an inch; and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulation shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. This insulation shall be further efficiently protected on the outside against injury or removal by abrasion. If this protection be wholly or partly metallic, it shall be efficiently connected to earth.

"The material used for insulating any high-pressure aerial conductor shall be such as will not be liable to injurious change of physical structure or condition when exposed to any temperature between the limits of 0deg. and 150deg. F., or to contract with the ordinary atmosphere of towns or manufacturing districts."

The two points, then, to be met are those of specific insulation and of thickness; the former determining the quality of the material, and the latter being governed by the striking distance.

It is an extremely difficult thing to arrive at a definite conclusion as to the exact sparking distance across an air-space with a given potential difference. It varies with the character of the opposing surfaces; with the resistance, capacity, and electromagnetic inertia in the circuit; with the nature of the current—that is, whether it is steady or alternating, and also in the latter case with the frequency. Sir W. Thomson concludes "that a Daniell's battery of 5,510 elements can produce a spark between two slightly convex metallic surfaces at one-eighth of a centimetre asunder in ordinary atmospheric air" (papers on "Electrostatics and Magnetism," page 259), which means that it requires 4,928 volts to strike across one millimetre. Warren de la Rue obtained a result very similar. Prof. Crookes, using an induction coil, takes much lower figures, and estimates the striking E.M.F. at 1 mm. as 920 volts. Mr. Ferranti, using a frequency of 200 and 20,000 volts, brought the voltage down to 620.

I propose for underground and covered conductors to specify as a minimum for 500 volts, or any E.M.F. under, 1 mm. thickness of dielectric, and ·5 mm. for each succeeding 500 volts or portion of 500 volts. Thus we should have for—

THICKNESS OF DIELECTRIC FOR DIFFERENT VOLTAGES.

Voltage.	Mm.	Inch.	Board of Trade. (inch)
500 and under	1	·04	·04
1,000	1·5	·06	·05
1,500	2	·08	·075
2,000	2·5	·10	·10
2,500	*3	·12	·125
5,000	*5·5	·22	·25
10,000	*10·5	·42	·5

* Material of superior quality—*i.e.*, 6 over 10.

CLASSIFICATION.

The classification of insulated conductors is most varied and perplexing as regards the dielectric. The most systematic method is that of Siemens, as regards the conductor. The pattern number gives the length in yards, which has a resistance of one-tenth of an ohm; divided by 4, it gives its carrying capacity in amperes; divided by 5, it gives its weight in pounds per mile; divided by 6, it gives its sectional area in mm.^{2}; divided by 4,000, it gives its sectional area in square inches. Nothing can be more charming. But when we come to insulation, we have types G, H, J, P, Q, R, L, M, N, LL, MM, NN, LLL, MMM, and NNN—all differing in the number and thickness of layers of pure rubber, of vulcanised rubber, of "special prepared material,' in taping, braiding, preserving with compound, lead, tarred jute yarn, and iron sheathing, and also in insulation resistance per statute mile in megohms at 60deg. N, NN, and NNN, are intended for 250, 2,500, and 5,000 volts respectively, and they vary in price in the ratio 64, 79, 93.

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* Paper read before the Institution of Electrical Engineers on Thursday, December 10, 1891.

TABLE A.—SPECIFIC INSULATION (σ) OF ELECTRIC LIGHT CABLES MANUFACTURED BY VARIOUS FIRMS.

Manufacturer.	Conductor.			Dielectric.				Insulation per mile at 60 deg. F., megohms.	Specific insulation (σ).	Remarks.
	No. of wires and approximate gauge.	Diameter (d).		Thickness (t).		Diameter (D).				
		inch.	mm.	inch.	mm.	inch.	mm.			
Siemens Bros. ...	7/22	·084	2·14	·076	1·93	·236	5·99	16,180	15·84	Insulated with "Siemens's special" high insulating indiarubber.
,, ...	,,	,,	,,	·078	1·98	·240	6·10	18,270	17·60	
,, ...	19/15½	·340	8·64	·080	2·03	·501	12·72	1,022	2·67	Ordinary pure and vulcanised rubber.
,, ...	61/15½	·612	15 54	·168	4·27	·949	24·10	824	1·90	
,, ..	51/12	·850	21·59	·190	4·82	1·230	31·24	4,082	11·17	Lead-cased; insulated with specially high insulating fibrous material (Bradford Corporation mains.)
,, ...	37/13	·651	16·53	·096	2·44	·844	21·43	2,567	10·00	
,, ...	19/14	·410	10·41	·079	2·01	·568	14·42	3,794	11·77	
,, ...	7/13	·286	7·26	·079	,,	·444	11·28	6,389	14·69	
,, ...	60/6½	1·656	42·06	·113	2·87	1·882	47·80	624	4·93	Lead-cased; insulated with impregnated fibrous material. (St. James's and Pall Mall Company's mains.)
,, ...	,,	,,	,,	,,	,,	,,	,,	830	6·56	
,, ...	60/10	1·170	29·72	·114	2·89	1·398	35·51	851	4·83	
,, ...	,,	,,	,,	,,	,,	,,	,,	1,014	5·76	
Silvertown	19/15	·360	9·14	·144	3·66	·648	16·46	6,768	11·64	Special pure indiarubber, then vulcanised indiarubber.
,, ...	,,	,,	,,	,,	,,	,,	,,	6,664	11·46	
,, ...	,,	,,	,,	,,	,,	,,	,,	6,549	11·26	
Callender	7/16	·192	4·88	·154	3·91	·500	12·70	380	·40	Vulcanised bitumen.
,, ...	19/18	·240	6·10	·155	3·94	·550	13·97	400	·49	
Glover	19/13	·460	11·68	·115	2·92	·690	17·52	600	1·50	Ordinary pure and vulcanised rubber, in use at the G.P.O. (specified 300 megohms per mile.)
,, ...	,,	,,	,,	,,	,,	,,	,,	515	1·28	
,, ...	,,	,,	,,	,,	,,	,,	,,	560	1·40	
,, ...	7/16	·192	4·88	·055	1·40	·302	7·67	855	1·91	
,, ...	,,	,,	,,	,,	,,	,,	,,	813	1·81	
,, ...	,,	,,	,,	,,	,,	,,	,,	833	1·86	
Fowler-Waring ..	1/18	·048	1·22	·036	·91	·120	3·05	6,522	7·20	
,, ..	1/16	·064	1·62	·043	1·09	·150	3·81	6,619	7·85	Waring compound.
,, ..	7/16	·192	4·88	·078	2·03	·352	8·94	4,835	8·07	
,, ..	19/18	·240	6·10	,,	,,	·400	10·16	3,280	6·48	
,, ..	19/16	·320	8·13	·095	2·41	·510	12·95	3,312	7·18	
,, ..	19/15	·360	9·14	·100	2·54	·560	14·22	3,145	7·19	
Henley	1/10	·128	3·25	·046	1·17	·220	5·59	564	1·05	Ordinary pure and compound indiarubber.
,, ...	7/16	·192	4·88	·054	1·37	·300	7·62	406	0·92	
,, ...	19/18	·240	6·09	·060	1·52	·360	9·14	329	0·82	
,, ...	1/14	·080	2·03	·040	1·02	·160	4·06	4,440	6·48	Ozokerited indiarubber.
,, ...	3/20	·078	1·98	·039	·99	·157	3·99	5,240	7·57	
,, ...	7/15	·216	5·49	·057	1·45	·330	8·38	2,210	5·27	
,, ...	19/14	·400	10·16	·080	2·03	·560	14·22	2,000	6 01	
,, ...	61/15	·648	16·46	·111	2·82	·870	22·09	2,200	7·55	
,, ...	61/12	·936	23·77	·217	5·51	1·370	34·79	7,146	19·98	Special cable—Class AA.

We are, however, told that they are tested in water when not intended for dry places, and Messrs. Siemens show that the insulation resistance diminishes as the size of the conductor increases.

For instance, type R: "Insulated with one layer of pure and two of vulcanised rubber, taped [braided, and drawn through preservative compound]. Tested under water, insulation resistance from 2,000 to 700 megohms per statute mile of 60deg.F., according to size of wire." The words in brackets form the sole difference between types J and R.

The Silvertown Company work up by areas of conductor, advancing by twentieths of a square inch, between $\frac{1}{10}$th square inch and one square inch. The insulator is composed of pure rubber, their best vulcanised indiarubber. They used to endeavour to maintain a constant ratio of diameters of conductor and dielectric, but the insulation resistance now varies with size. The wires are all rigidly tested under water, and give over 2,500 megohms per mile.

But the classification into letters is as perplexing as with nearly all the other makers, except, perhaps, the Fowler-Waring Company, who have only one dielectric and one form of protection—viz., lead covering.

The Standard Underground Cable Company, of U.S.A., who use Waring's compound, specify the thickness of insulation in mils. Their smallest is 31 mils, nine mils less than the proposed minimum. Their thickest is 188 mils, or 7·5 mm., which is good enough for 7,000 volts.

This classification into types is a manufacturer's question. We cannot interfere with it, but we do earnestly hope that they will study the convenience of the user by reducing their types to the lowest possible number, but, above all, by removing from their lists the cheap and nasty.

The evil of this loose system was strikingly exemplified in a case which recently came before the law courts, when some of the ablest counsel were busily employed for several hours in endeavouring to explain what was meant by "C" quality wire, with but little result, none of the expert witnesses present being able to throw any light on the subject.

I am much indebted to different firms for the information which they have cheerfully given me to enable me to determine the specific insulation of the different materials they use; and as this information may be very useful, I tabulate it, and submit it herewith (Table A).

This table must not be taken as a competitive examination of the relative merits of the different goods. I have taken them just as they came, and I have not indicated the classification, simply because I did not know it.

SPECIFICATION.

The consulting engineer can afford to smile at classification, for he can draw up his own specifications; but it is extremely difficult even to do this without a reference to some well-known maker's class.

No wire should ever be used which cannot be subjected to a test under water. Insulated wire is supplied which is specified *to be used in dry places only.* But as this stuff is cheap, inspection is ignored, and dry places are not always dry; its general use follows; dampness and leakage result, electrolysis sets in, and the conductor is eaten away, if it is not charred, or even set on fire.

It is impossible to speak too strongly on the terrible abuse of ordinary precautions which is encouraged by the manufacture of these cheap cables. It destroys confidence, introduces danger, and discourages the industry.

A very curious practice has recently developed itself among our wiring contractors. They have asked manufacturers to reduce the over-all diameter of their insulated conductors, in order to enable them to utilise the grooved boarding which they happen to have in stock. In other words, the interests of the users of the electric light are to be sacrificed to the interests of the wood-carvers!

I do not believe in danger to person in high-pressure systems when proper material is used. They are so safeguarded, that any contact between primary and secondary—practically the only source of danger—leads at once to safety. I fear more danger of fire in both systems, and this more in low-pressure systems than in high-pressure ones, for they are not so safeguarded, and are more open to abuse. In fact, the numerous accidents that have occurred from imperfect work on low-pressure systems has already attracted serious attention to its dangers.

I prefer, then, to specify that:

1. The copper must be pure, and such that at a density of 8·9 its specific resistance is 1,616—that is, it must comply with Matthiessen's standard of pure hard-drawn copper.
2. If it is to be covered with any vulcanised material, it must be tinned.
3. No single size smaller than No. 19 (·04in. or 1 mm. wire) is to be used.
4. No single wire greater than No. 16 is to be used.
5. All larger sizes are therefore to be stranded.
6. The weight of copper used is to be such that the loss of volts between the distributing switch and the furthest lamp, when full load is on, shall not exceed 1 per cent. Hence the current which each conductor has to carry must be given.
7. The dielectric to be employed must be described, with its specific insulation, in terms of a quadrant cube of guttapercha at 75deg., which is taken as unity.*
8. The thickness of dielectric must be given for the different sized conductors used.
9. The various modes of preserving and protecting the insulated cables must be given.
10. Every coil should have attached to it the maker's certificate, testifying that it complies with this specification, and that it has been tested under water.†

TESTING.

There are upwards of 130,000 miles of cables submerged in the ocean, and I cannot recall to mind a single fault that has occurred since 1865 through a manufacturer's defect that has escaped the probe of the tester. Every cable is most rigidly and carefully tested under water. Why do not users do the same with their electric light conductors? It would be the greatest safeguard for security.

There is a widespread impression that the insulation varies inversely with the potential differences employed, and that the higher the voltage used the more accurate the result. This is a mistaken notion. The following experiment was made to show its fallacy:

TABLE SHOWING RESULTS OF INSULATION TESTS OF GUTTAPERCHA CORE WITH VARIOUS VOLTAGES.

Number of cells. (Leclanché.)	Galvanometer readings.			Insulation after one minute's electrification.
	1st min.	2nd min.	3rd min.	
				Megohms.
10	18½	16	14½	164·3
40	76	67	64	162·2
100	179	163	157	173·3
200	181 7,000ω	168	162	168·2
300	192 4,000ω	181	177	172·2
400	188 3,000ω	177	173	174·1

The advantage of high voltage is that it breaks down incipient faults; but, on the other hand, if too high, it may put in faults; it is therefore advisable that the insulation be tested with a voltage, say, not less than 50 per cent., and not more than 100 per cent. above the voltage it is intended to resist.

[ERRATA.—Page 566, for

$$\sigma = \frac{\rho l \, 2 \pi}{\log_\epsilon \frac{D}{d}}$$

where ρ is the specific resistance in C.G.S. units, etc., read:

$$\sigma = \frac{R^1 l \, 2 \pi}{\log_\epsilon \frac{D}{d}}$$

where R^1 is the resistance in C.G.S. units, etc.

For "ρ" in the note * "A simple approximation," etc., substitute "R^1."]

LITERATURE.

Electricity up to Date. By JOHN B. VERITY, M.I.E.E. Frederick Warne and Co. 1s. 6d.

Electrical books have hitherto not had a very large popular demand. Technical introductions to the science and practice of electricity have now, however, begun to be followed by books for the consumer, and in the work before us we have an extremely useful pocket electrical hand-book. Its exterior is popularly attractive, with the appearance of not being too "dry," for it is a small volume in white parchment cover, with title in red and black, something after the nature of "English as She is Spoke," or "Dancing as It Should Be." The title "up to date" certainly appeals to the average enquirer, and when he has invested his eighteenpence and turns to the matter he will find a vast deal of the information he requires in readable and interesting form. Mr. Verity begins, of course, with *electron*, and then shortly explains the various means of producing electricity. His explanations, though sufficiently correct, are not always scientifically so; for instance, the energy of a primary battery is not obtained by the "destruction" of zinc, but by its oxidation. Again, Mr. Verity uses continually the term "inductional" electricity. He says current is produced in a dynamo by magnetic induction; it would be better at once to state that such current is obtained by forcible *motion* in a magnetic field, whence the name dynamo. The action of the dynamo is popularly explained in a separate chapter with some detail, but the chief difficulty in the way of the ordinary person—that is, the difference between direct and alternating currents—is perhaps complicated by the statement that "so rapid, in fact, are the alternations that the current generated is practically a steady and *continuous* flow"—which certainly (in the sense it would be read) it is not. Mr. Verity mentions the various sources of power, and gives an illustration of a Victor turbine. The arc light is next treated, and the first practical use for it is quoted as that in 1858 for the construction of Westminster Bridge. The Edison-Swan lamp and the Sunbeam lamp are succinctly described, and the sanitary advantages insisted upon. In the chapter on "Storage" we again come across the popular mis-statement (started by the public press at the time of Sir William Thomson's wonderful box), that "electricity is stored"—a statement that should not be found in any works now issued to the public. The ordinary mind should have no difficulty in grasping the true theory of chemical reactions. The after explanation of the E.P.S. cell becomes thus vitiated by the first sentences. In the matter of wiring a house, Mr. Verity shows himself perfectly at home, and the chapter on this part of the electrical engineer's work is admirable, and he rightly insists on the necessity of employing experienced and competent engineers. We notice an amusing joke, incidentally introduced, *apropos* of the householder's ignorance of technical terms: when informed that a leak was due to "earth," the question was asked, "Then why wasn't the earth removed from the house before the wires were put in?" The action of switches and wall sockets are explained and illustrated, and a chapter on private installations gives a plan of the arrangements required, with a photograph of the author's 50-light installation at Weybridge. To ordinary people, however, the public supply most interests them, and this question receives as full attention as the average householder requires, with explanations of the high-pressure, low-pressure, and three-wire systems, which, if not technically instructive, serve their purpose. The chapter contains a list of the principal central supply companies, with names of their chairmen and amounts of their capital, district supplied, number of lamps connected, price charged, etc. Supplemented, as it is, with a coloured map showing the districts in London over which the companies have power, it makes this part of Mr. Verity's little book useful for reference. We are then given two short chapters upon transmission of power and electric traction, with illustrations of hauling plant for mines and an overhead electric tramway line. A *résumé* of the Board

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* This can easily be deduced from its insulation in megohms per mile when the dimensions and the temperature coefficient for the material are given.

† Messrs. W. Glover and the Silvertown Company already do this.

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TENDERS—HIGH AND LOW.

It would be a piece of affectation on our part to refer to the *Contract Journal* as we should refer to a paper outside our influence, when it is generally known that that journal is closely connected with this paper. The *Contract Journal* deals almost exclusively with matters relating to contracts; hence, in its issue of December 16 was given the list of tenders for the extension of electric lighting at the central offices of the London County Council. There were thirty-two of these tenders, ranging from £1,490, the lowest, to £2,996, the highest. A difference of two or three hundred pounds, or even of five hundred, upon so comparatively small a job might be understood, but what reasonable hypothesis can explain a difference of £1,506? If the lowest tender, or even half-a-dozen of the lower tenders, permit the work to be done properly at a reasonable profit, what about the profit upon the higher tenders? If, however, the higher tenders have been carefully got out and only a reasonable profit added, what about the lower tenders? It is scarcely conceivable that tendering upon the same specification permits such wide differences, yet here is proof that it does. Immediately below the series of tenders above referred to our contemporary gives another series from eleven builders, the difference between the highest and lowest being £1,777; but in this case the highest is £7,977, so that the percentage difference is far below that which holds in the electrical tenders. Further, to those who understand the work, the reason of differences, and somewhat large differences, in building operations is easily explained, but similar reasons are not to be found for large differences in electrical work of the kind under consideration. In the latter case, a diminution of the higher tender about 22½ per cent. would bring it on a level with the lower, but the former would require a diminution of about 50 per cent. to bring the highest down to the lowest. It would be interesting, if it were possible, to obtain the continuation of the history of such work—by this we mean an exact and authentic statement of the cost of the work to the contractors. We are not going to hint that mistakes have been made in this case, but for the present prefer to imagine that most tenders were made upon the idea that the London County Council, being a wealthy corporation, was one that could well afford to pay for work done. That argument will sufficiently account for many of the vagaries of the tendering. We think we have sufficient knowledge of the "policy" of our contemporary to know that if it takes up this question some hard things will be said of electrical engineers, and justifiably so. The London County Council may be a wealthy corporation, but it is spending the money of the ratepayers, and there is no reason why they should be asked to pay more than is necessary because they pay collectively rather than individually. There is a tendency among certain classes of shopkeepers to charge a customer according to his looks, and it certainly seems as if the same view was held engaged in the engineering world. However, to put this matter right, from a financial point of view, and so far as our company is concerned, we beg to state that the particular Mr. Gwynne who is interested in the success and welfare of our company is Mr. James Eglinton Anderson Gwynne, J.P., of 97, Harley-street and Folkington Manor, Polegate, Sussex, and the owner of the Pilsen Electric Works, who, moreover, since the date of the first announcement in your "City Notes," has also taken over our Mr. Arthur Shippey's entire interest in the company, also Mr. Shippey's vested interest in the Curtiss, Crocker-Wheeler, and Waterhouse electric systems; and we have no doubt in due course that Mr. Gwynne will financially handle the above valuable group of inventions in the manner they deserve to be developed in the European markets, and this probably without the assistance or intervention of the firm alluded to.

Knowing that your journal has a known reputation for inserting authentic information, and that it also aims in carrying out as far as possible *your well-known motto* for correspondents, we will thank you to insert this letter in your next issue, and by so doing you will oblige.—Yours, etc.,

SHIPPEY BROTHERS, LIMITED,
(Per William B. Hammond.)

13 and 14, Cheapside, E.C., Dec. 17, 1891.

UNDERGROUND LIGHTING MAINS IN PARIS.*

BY E. DIEUDONNÉ.

(Concluded from page 512.)

Mains of the Compagnie de la Place Clichy.—The system of mains adopted by this company is essentially different in many ways from all the others laid in Paris. Here there are no conduits—of cast iron, concrete, earthenware—and no bare cables. The cables are all heavily insulated, and simply laid at the bottom of a trench under the pavement on a layer of sand. [It is perhaps as well for English readers to note that the subsoil of Paris is of an entirely different nature to that usually experienced in the damp soil of London, consisting usually of light, dry, stony earth, like crushed stone.] The laying of the cables becomes in this case a very rapid operation, the time of interfering with the pathway is considerably diminished as compared with the time required for the other systems described. To open the trench, lay the cables, and fill up again quickly, are the three phases of this system. The junctions and connections are made, under a portable shelter, in cast-iron boxes, as afterwards described.

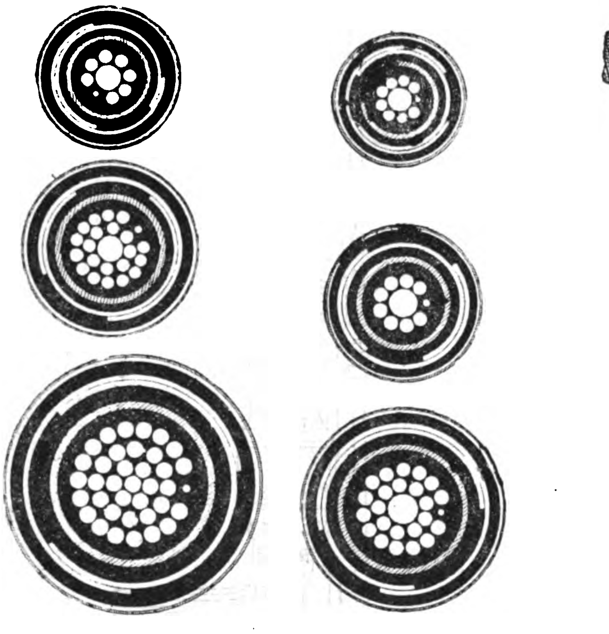


FIG. 57.

The cables emplo[illegible] Compagnie de la Place Clichy are of the Sie[illegible]ufactured at Belfort by the Société Alsacienne de Constructions Mécaniques. The author of these articles had the good fortune to see the manufacture of this class of electric cables at the works of Messrs. Siemens themselves at Charlottenberg, near Berlin. The process of insulation is extremely carefully carried out, and the insulated cables are covered with lead. They are classed ordinarily into four different types, corresponding to various inherent requirements of employment combined with economy:

(*a*) Conductors with lead sheath, unprotected with exterior envelope.

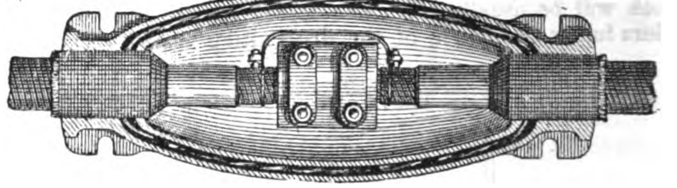
(*b*) Conductors with lead sheath, covered with a serving of asphalted jute.

(*c*) Conductors with lead sheath, covered with layer of insulation, again wrapped by two iron strips wound spirally and simultaneously around the cable, Fig. 57. The whole is finally covered with tarred jute.

(*d*) Lastly, those in which the external wrapping is of iron wire.

Among these four types of cable the mains engineer will exercise a judicious selection. When the section of the conductor does not exceed 30 square mm., a single copper wire is used; for larger sections the core is formed of stranded wires. The insulation is composed of a serving of cotton or jute, highly dessicated in vacuum, and then impregnated with an insulating compound the description of which is not divulged. The proprietors of the process affirm its superiority to indiarubber, guttapercha, and similar materials, a claim which must so far remain for us a simple allegation. The thickness of this insulation depends upon the voltage it is to withstand. Amongst the strands forming the cable is an insulated strand of smaller section, which acts as a pilot wire to measure the difference of potential at the extremity of the cable.

FIG. 58.



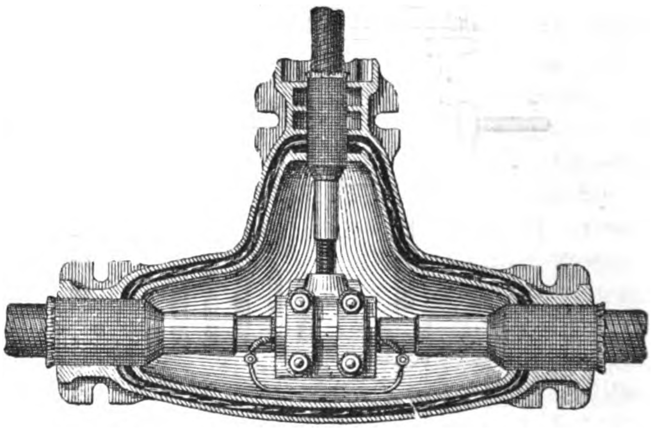


FIG. 60.

These mains, although sufficiently armoured with their iron sheathing, when laid in their trenches and covered with a layer of sand are, nevertheless, liable to various eventualities; such as a violent stroke from a pickaxe, if there is nothing to call the attention of the labourer to their presence in the ground. It is thought sufficient generally to lay over the trench, just below the pavement, a galvanised iron wire meshing, which would serve to attract the attention of any workman taking up the flags. In many cases this would appear insufficient. Occasionally it would be better instead of the metallic meshing, to use creosoted deal boards. When passing under the roadway the cables are threaded through iron pipes.

The distribution in the district of the Place Clichy is on the five-wire system, supplied by one or several groups of

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[illegible]icien.

dynamos connected in parallel, giving the requisite pressure between the exterior conductors. Two feeders are therefore all that are required to connect the exterior conductors with the dynamos. The lamps are distributed judiciously on the four bridges formed by the intermediary conductors.

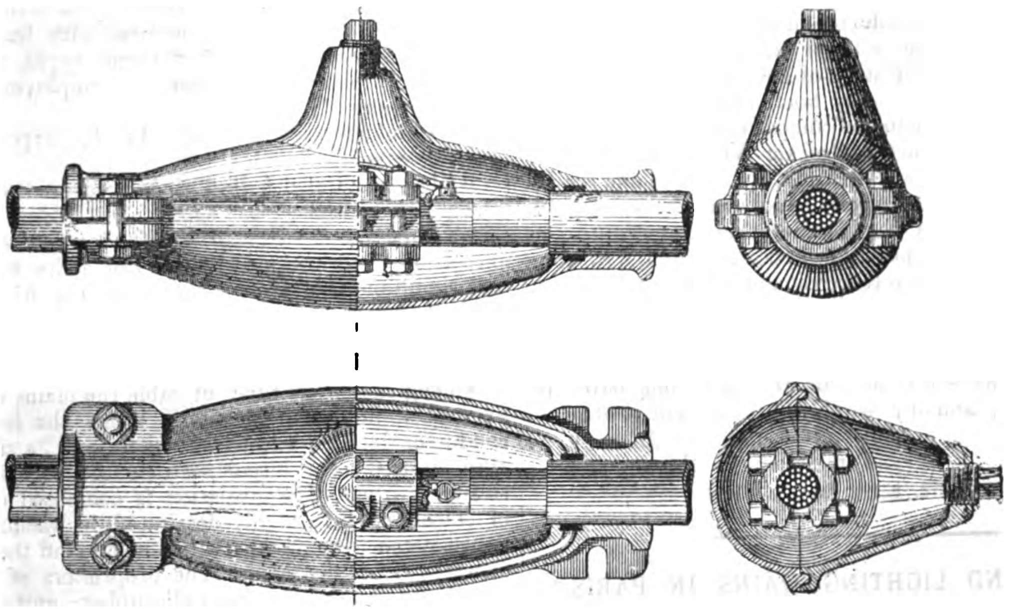

FIG. 59.

It follows that the number of cables to be laid in the trench will be usually five, and sometimes seven when the feeders follow the course of the distributing mains. The cables are distinguished by means of small metallic clips, placed upon them at short intervals.

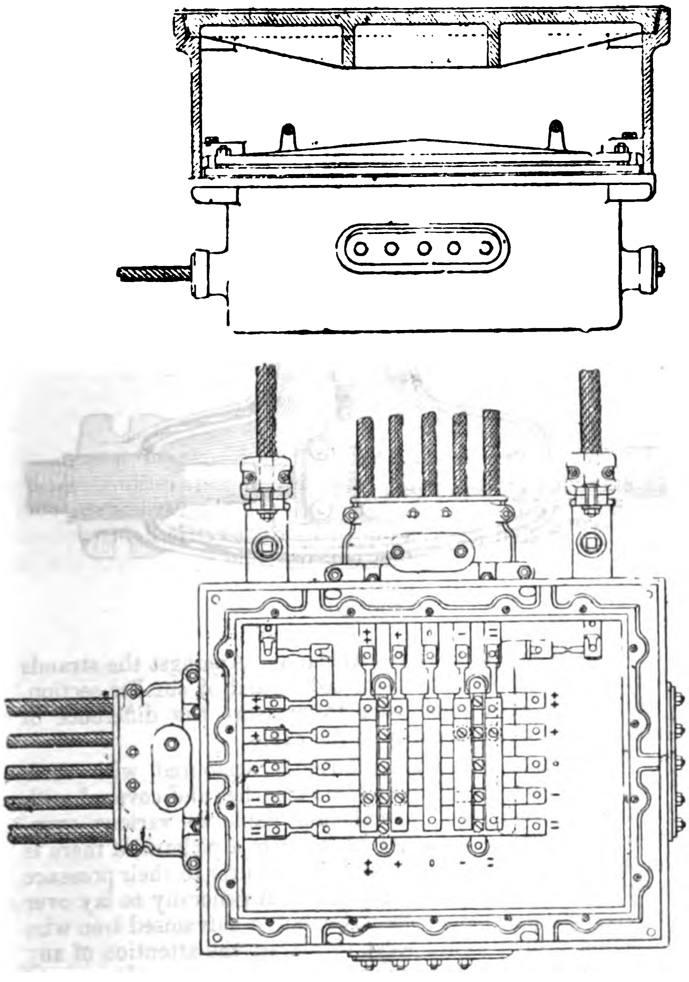

FIG. 61.

These mains have a high insulation resistance; the only places which would give any cause for trouble are the points of junction of cable to cable or of service mains. In laying new mains the greatest possible precaution is therefore taken. The end of a cable is never left bare; as soon as it is prepared for junction, it is inserted in a sleeve and buried in a mass of insulating material.

Simple junctions are made in junction-boxes cast in two pieces, see Figs. 58 and 59, having stuffing-boxes for tightly gripping the cable and preventing the intrusion of moisture. The two cores are butted and tightly screwed between two solid copper sleeves. The pilot wires are

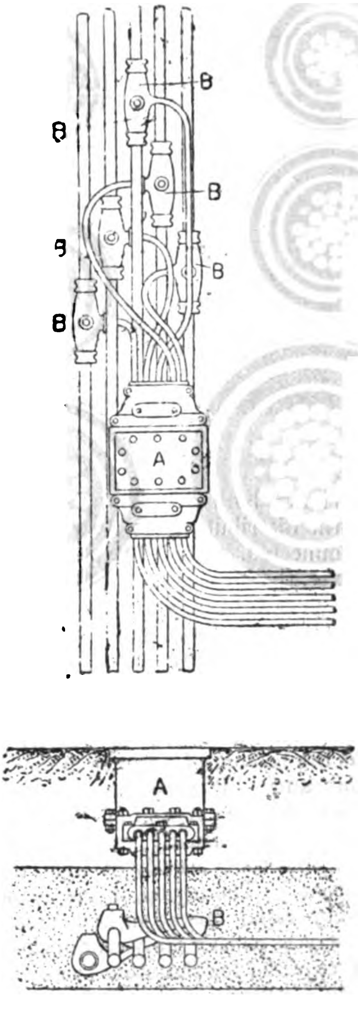

FIG. 62.

In the circuit m, q, n, m, we have

$$e = \mathrm{X}\,x - \mathrm{D}\,d \therefore e = \mathrm{A}\left(x - \frac{a\,d}{b}\right) \quad . \quad . \quad . \quad (5)$$

In the circuit q, p, n, q, we have

$$\mathrm{E} = \mathrm{F}f + \mathrm{B}\,b + \mathrm{D}\,d = \mathrm{A}\,\frac{a+b}{b}f + \mathrm{A}\,\frac{a}{b}\,b + \mathrm{A}\frac{a}{b}\,d$$

$$= \frac{\mathrm{A}}{b}\left([a+b]f + a\,b + a\,d]\right). \quad . \quad . \quad . \quad (6)$$

From (5) and (6)

$$\frac{e}{\mathrm{E}} = \frac{b\,x - a\,d}{f(a+b) + a\,b + a\,d} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

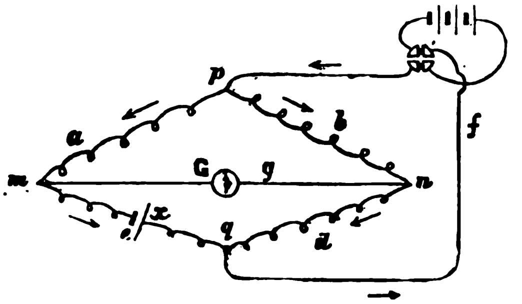

FIG. 5.

Now reverse the testing battery, obtaining $-\mathrm{E}$ for E, and d^1 for d

$$\frac{e}{\mathrm{E}} = \frac{-\,b\,x + a\,d^1}{f\,(a+b) + a\,b + a\,d^1} \quad . \quad . \quad . \quad . \quad (8)$$

Add numerators and denominators, respectively of (7) and (8),

$$\therefore \frac{e}{\mathrm{E}} = \frac{a\,(d^1 - d)}{2f\,(a+b) + 2\,a\,b + a\,(d^1 + d)} \quad . \quad . \quad . \quad (9)$$

Subtract ditto,

$$\frac{e}{\mathrm{E}} = \frac{2\,b\,x - a\,(d^1 + d)}{a\,(d - d^1)} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

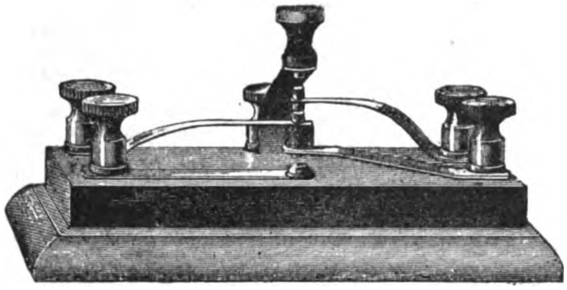

FIG. 6.

By equating (9) and (10) we have

$$x = \frac{a\,(d^1 + d)}{2\,b} - \frac{a^2\,(d^1 - d)^2}{2\,b\,(2f\,[a+b] + 2\,a\,b + a\,[d^1 + d])}.$$

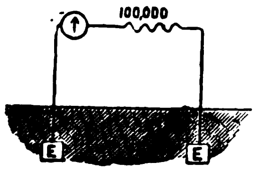

FIG. 7.

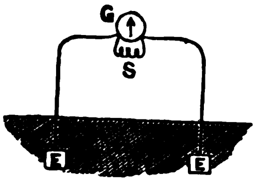

FIG. 8.

For practical purposes this complete formula need be applied only in extreme cases. Using the simple relation

$$x = \frac{d^1 + d}{2} \cdot \frac{a}{b}$$

the following values were obtained at different times for the resistances of the earth-plates before referred to:

TABLE II.

Date.	x	y	z
3/6/91	·325	3·83	16·6
,,	·330	3·84	16·725
4/6/91	·320	3·945	17·325
,,	·348	3·768	17·263
5/6/91	[illegible]	3·875	17·20
[illegible]	[illegible]	3·845	17·545
[illegible]	[illegible]	·808	17·513

Between these tests the plates were used from time to time for signalling work and line testing. It is seen that their resistance varies but very little.

By the formula (9) we are able to find e, the distributing E.M.F., in terms of E, the E.M.F. of the testing battery.

(*To be continued.*)

ELECTRIC LIGHTING OF HOUSES.

At the second ordinary meeting of the Dundee Institute of Architecture, Science, and Art, Mr. F. Grant Ogilvie, principal of Heriot-Watt College, Edinburgh, delivered a lecture on "Electric Lighting of Houses." Mr. Charles Ower (president) occupied the chair. The chairman said the lecture was one of two which had been specially arranged fo̊r in connection with the fact that Dundee was setting about introducing the electric light.

Mr. OGILVIE began by referring to the nature of electric light, and detailed some of the principal facts in relation to electricity which would have to be dealt with in its distribution in houses. He explained how the wire, heated by the electric current, gave off light, but at the same time, when made of certain metals, would melt. The lecturer then demonstrated the manner in which an electric lamp gave out light. The filament in the lamp, being made of carbon, glowed when the current was passing through, and during the process particles of carbon were thrown off, and in time the filament became thinner and thinner until it broke. The average life of a lamp was about 1,000 hours burning. The lecturer then explained the uses of the electric battery, and the signification of the electrical terms ampere and volt, which signified the strength of the current and the difference of electric pressure. By means of diagrams shown on the blackboard with coloured chalks, Mr. Ogilvie represented how electricity could be distributed in houses. The two wires were brought into the house, the one being at an electrical pressure of 100 volts above the other. These two wires were connected by another passing through the lamp, which glowed when the electric current was passed. The fittings for the distribution of the electricity were, he said, of importance. The conductor of the electric current was of copper or an alloy of copper, and to prevent electricity escaping from one wire to another, or into the material of the wall, the copper wire was entirely surrounded by some substance which offered great resistance to the flow of electricity. The way in which wires could be carried over a house was then detailed, and the use of the switch for turning on and off the current minutely explained, a switch being handed round among the audience to clearly show how it acted. It was usual also to have a wire not copper which formed part of the circuit, and which was of a substance easily fused. The object of this was to prevent any accident occurring in the event of some unforeseen contact between the two wires. This fusible piece of wire prevented the possibility of such an accident, as should such a mishap come to pass the wire fused and the injured part of the circuit was "cut out." A number of electric lamps suitable for fixing in different positions were exhibited to the audience. These and an exhibit of lead casings and various fittings were lent by the Brush Company. Mr. Ogilvie remarked that it was the exception now to find an ugly electrical fitting. The practical methods of measuring the electric power supplied to a house were explained generally and illustrated by the Shallenberger meter, an example of which was exhibited to those present. The lecturer at the close referred to the cost of electric light, especially as compared with the cost of gas, and by means of calculations demonstrated how the different prices might be arrived at and compared. He showed that under ordinary domestic conditions 1,000 c.p. of gas gave about the same amount of light as 12 Board of Trade units of electricity, so that the pence price of a B.T. unit taken as shillings might be compared directly with the quoted price of gas. To the price of this quantity of electric energy there would have to be added about one-fifth of the price of a lamp, say 9d. This addition, however, might soon be expected to be reduced by one-half. Though gas was at present cheaper than electricity, additional 10 miles to be delivered during the next few months. In shiplighting, eight of the new warships at present building for the Admiralty have been wired by cables of our manufacture, and some of the large shipbuilders have adopted them for installation on board the steamships building in their yards. In the electric lighting and transmission of power in mines, the cables have been extensively used, and they contribute very greatly to the success of this difficult and important work. We have also manufactured special wire for use with the explosives employed in blasting and torpedo experiments, and for many more of the ever-increasing number of electrical applications. In telegraphy the leading railway companies are adopting lead-covered wires for the tunnels, yards, and stations, and many miles of our cables have been so used during the past year. In telephony the Government has employed our cables exclusively for the London end of the Paris telephone lines, and also for connecting up the various centres in London. Large orders have also been entrusted to us by the private telephone companies, and we are at present laying a 100-wire cable through Paris for the French Government telephone service. We have recently dispatched 15 miles of similar cable to Sydney for the Government telephone service there. Only our cables will be employed for the new central station at Sydenham, which will supply electric light to the Crystal Palace during the forthcoming exhibition. Other large orders are in hand, and the prospect of future business is exceedingly good. In my last report I referred to the fact that rubber-covered wires were often specified to the exclusion of all others, and that we deemed it advisable to be prepared to supply these if it became necessary. In many instances we have been able to secure the adoption of our cables in preference to those which are rubber covered, and all the work referred to in this report has been carried out with cables manufactured under those patents and processes which are the exclusive property of the Company. The works at North Woolwich have never yet been worked to anything approaching their possible output, and consequently we cannot yet show a profit on our work. Sufficient, however, has been done during this year to demonstrate not only the value of our manufactures and the extent and variety of their application, but to justify the firmest confidence in the future of the Company.

(Signed) ALFRED E. MAVOR.

Dr. BALANCE-SHEET, SEPTEMBER 30, 1891.				£	s.	d.
Capital—						
Authorised, 40,000 shares of £5 each	£200,000	0	0			
Issued, 20,000 shares £4. 10s. per share paid up	90,000	0	0			
300 founders' shares issued as fully paid to vendors	1,500	0	0			
	91,500	0	0			
Deduct arrears of calls	150	0	0			
				91,350	0	0
Creditors				15,286	12	9
Liability on bills receivable discounted	1,657	6	2			
				£106,636	12	9

Cr.				£	s.	d.
Cash at bankers and in hand				1,165	15	2
Debtors				13,656	0	10
Stock				14,011	4	2
Office furniture in City offices and factory				515	7	3
Shares in other companies				25	0	0
Machinery and plant as per last account 30th September, 1890	£8,977	12	2			
Additions during the year	6,116	14	8			
				15,094	6	10
Works and buildings—						
At North Woolwich, as per last account September 30, 1890	12,907	17	1			
Additions during the year	1,662	5	9			
				14,570	2	10
Patents and goodwill as per last account September 30, 1890				41,000	0	0
Preliminary expenses as per last account September 30, 1890				3,325	8	6
Profit and loss account as per last account September 30, 1890	1,764	16	2			
Add loss for the year ending September 30, 1891, as per account	1,508	11	0			
				3,273	7	2
				£106,636	12	9

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDING 30TH SEPTEMBER, 1891.

Dr.	£	s.	d.
Directors' fees (not drawn)	2,000	0	0
Rent, rates, and taxes	1,815	2	9
Office expenses and advertising	888	16	10
Fees on patents	186	0	0
	£4,889	19	7

Cr.	£	s.	d.
Gross profit on cables, after deducting salaries and other expenses	3,377	13	7
Transfer fees	3	15	0
Balance—loss for the year ending 30th September, 1891, carried to balance-sheet	1,508	11	0
	£4,889	19	7

NEW COMPANIES REGISTERED.

California Gas, Water, and Electric Light Syndicate, Limited. Registered by Oldfield, Bartram, and Oldfield, St. Stephen's-chambers, Telegraph-street, E.C., with a capital of £2,000 in £1 shares. The objects for which this Company is established are sufficiently indicated by the title.

Automatic Gas Lamp Lighter Company, Limited.—Registered by Church, Rendell, Todd, and Co., 9, Bedford-row, W.C., with a capital of £6,000 in £1 shares. Object: to carry into effect an agreement, made November 26, between P. Everitt of the first part, G. Salter and Co. of the second part, and this Company of the third part, and generally to carry on business as mechanical, gas, and electrical engineers, machinists, brass and iron founders, etc. There shall be four Directors. The first are P. Everitt, G. Poore, G. Salter, and J. H. Birch. Qualification, 250 shares. Remuneration to be determined in general meeting.

Chloride Electrical Storage Syndicate, Limited.—Registered by Hays, Schmettau, and Co., 31, Abchurch-lane, E.C., with a capital of £262,500, in 250,000 £1 preference shares and 12,5000 £1 founders' shares. The objects for which the Company is established are to adopt and carry into effect a provisional agreement, made November 30th, between the Electric Storage Battery Company and the United Gas Improvement Company of the one part and J. A. E Hickson, on behalf of this Company, of the other part, for the acquisition of certain patents and to develop and work the same, and to carry on the business of an electrical company in all its branches; and, further, to carry on the business of engineers, ironfounders, copper smelters, steel makers, engineers, merchants, bankers, colliery proprietors, company promoters, brokers, etc. The first subscribers are:

	Shares.
J. E. Yates, 9, Solent-crescent, West Hampstead	1
W. J. Tomey, 24, Granard-road, Wandsworth Common	1
G. S. P. Cooke, 53, Chadwick-road, Peckham	1
H. J. Rumball, 16, Ruvigny-gardens, Putney	1
F. B. Liley, 58, Sandmere-road, Clapham	1
G. S. Ludlow, 34, Werter-road, Putney	1
E. J. Newbatt, 57, Cowley-road, North Brixton	1

There shall not be less than three nor more than nine Directors; the first being the first seven signatories to the memorandum of association. Qualification, 500 shares. Remuneration, £1,500, divisible.

CITY NOTES.

The Sims-Edison Torpedo.—Major-General E. Harding Steward has joined the Board of the European Sims-Edison Electrical Torpedo Company.

City and South London Railway.—The receipts for the week ending December 13 were £815, as against £810 for the week ending December 6.

Eastern Extension Telegraph Company.—An interim dividend for the quarter ended September 30 last of 2s. 6d. per share has been declared by the Directors, payable on the 15th prox.

An Electrical Finance Company is being formed, with a capital of £100,000, to assist local authorities in dealing with the powers granted to them under the Electric Lighting Acts.—*Financial News.*

St. James's Electric Light Company.—The 10,000 new £5 preference shares recently offered to shareholders by the Directors at 30s. premium have been largely over-subscribed. These shares were allotted on December 11.

Interim Dividend.—The Directors of Crompton and Co., Limited, have declared an interim dividend at the rate of 7 per cent. per annum on the preference shares, and 5 per cent. per annum on the ordinary shares for the half-year ended September 30 last.

The Phosphor Bronze Company inform us that they have acquired the sole license for the manufacture of Bull's metals, which they now supply in the form of ingots, billets, castings, forgings, stampings, rolled rods and sheets. The extreme malleability, tensile strength, and durability of these alloys render them specially adapted for the wants of engineers, shipbuilders, and others requiring a strong non-corrosive metal of high quality at a moderate price. The inventor and patentee, Mr. John C. Bull, has joined the Company as consulting engineer and chemist, and will superintend the manufacture of his alloys at their various works.

Elmores.—A "Confiding Investor" writes to the *Financial News* in a most lugubrious strain about the prospects of this Company. He points out that the accounts to June, the end of the financial year, have not yet reached him. He also says that he "invested in the Company's shares on the strength of a letter from Mr. W. Elmore, in which he said: 'I now predict that at no very distant period the shares will stand at £50 instead of their present price' (then about £8). The shares are not now saleable at £3. Circulars issued by the persons connected with the promotion of the Company estimated the profits to be earned as sufficient to pay a dividend of 100 per cent., and carry over £34,000 surplus as well each year. The Company has been in existence nearly three years, and although a dividend of 50 per cent. was paid to the original shareholders, this was derived from the sale of one of the patents to a subsidiary company, and has, therefore, nothing to do with at the Chicago Exhibition. The exhibit will require 1,500 h.p. to 2,000 h.p. for the operation of the machinery. An electric railway will be laid, electric boats supplied, and a model theatre, besides public lighting. A special building is asked for.

Progress of Invention.—The U.S. Patent Office will exhibit at the Chicago Exhibition a comprehensive array of models to illustrate the wonderful progress of mechanical civilisation. One group of models will show the progress of the printers' art from Gutenberg's crude invention to the latest rotary perfecting and folding printing press, capable of turning out newspapers at the rate of many thousands per hour. Other groups will show the development of the steam engine, sewing machine, agricultural machinery, the application of electricity, and other branches.

Kensington.—The Works and Sanitary Committee of the Kensington Vestry, at their last meeting stated that they had considered the letters from the Board of Trade forwarding the description of the system of electric lighting proposed to be substituted by the Chelsea Electricity Supply Company in place of that now in force, and recommended that the Board of Trade be informed that the Vestry saw no objection to the proposed new system being adopted, provided a code of rules and regulations similar to those now in force be imposed by the Board.

The Hughes Telegraph.—There are now 100 Hughes printing telegraphs at work in Berlin, out of a probable total of 2,000 in the countries using this wonderful instrument. The great advantages of speed and clearness are well shown in the fact that the usual speed of the Hughes telegraph is 1,200 to 1,300 words an hour in printed Roman letters, and in the Berlin chief telegraph office are operators capable of sending 1,600 words in the hour. In a great number of lines running from Berlin there are more than 500 messages sent a day, the activity of the Morse system being limited to 200 a day.

Fast Electric Railroads.—It is not all honey in the working of an electric road, especially when 25 miles an hour are run with what are practically ordinary tramcars, run at this speed in competition with the railway company. On the St. Paul and Minneapolis track, to which we have before referred, a car jumped the track, and four persons were fatally injured. With such conditions true railway conditions come into play, and the 18ft. car with a short wheel base were certainly not satisfactory, and double-truck cars are to be used in future. The unfortunate incident will at least serve to indicate the kind of service for which electric cars are now being employed.

Waterford.—At the last meeting of the Waterford Corporation, a letter was received from Mr. T. F. Strange, law adviser to the Corporation, stating that he had taken the necessary steps to obtain the provisional order to enable the Town Council to light the city by electricity. He applied for £150 to carry the matter out. This amount was voted. The Special Lighting Committee have decided to apply to Government for a loan of £20,000 to carry out the public lighting, and though in all probability the cost will not amount to this sum, the amount now paid for public lighting will more than cover the instalments of principal and interest levied by the Government.

Featherstone.—At a meeting of the Featherstone Local Board last week a letter was read from Lord Masham's agent, offering to light up North Featherstone for a term of 15 to 20 years with electric light, or so long as the coal on the Ackton estate lasted and continued to be worked, for the sum of £20 per year and 4d. per hour during the time the current was used. The Board favoured Lord Masham's offer, but it was stated that Castleford Gas Company had the right of lighting North Featherstone, and it was also mentioned that a license would be required from the Board of Trade before the Board could adopt the offer made by Lord Masham. The offer was accepted.

Exhibition at Earl's Court.—A United Services Exhibition is to be held in the grounds at Earl's Court, to be opened in May next. It is considered that the auxiliary forces—and particularly the volunteers—have not been properly represented in any exhibition. The Welcome Club, in the Western Gardens, will be reconstituted especially for the benefit of officers and their friends. The buildings and grounds will be illuminated by electric lighting and otherwise, on a grander scale than heretofore, and first-class music will be made a special feature. Naval and military displays, drills, sports, and competitions will be provided, and prizes will be offered for various competitions.

Budapest Electric Railway.—Some particulars recently given of the proposals for the electric railway between Vienna and Budapest reveal a daring and comprehensive plan. The distance is 150 English miles, which is to be covered in 75 minutes, the speed in regular working to be 200 kilometres, or 124 miles an hour. There would be two main generating stations, with 100 sub-stations along the route, and only four stopping-places. The cars are to be 130ft. long on four bogie carriages, and shaped to cigar-shaped point to reduce the air resistance. The cars are to be provided with two powerful motors at each end, the current being picked up from bare conductor rails by special wheels. It is thought permission will be obtained, and the line put in hand before very long.

Typological Museums.—Lieut.-General Pitt-Rivers, D.C.L., F.R.S., read a very suggestive paper before the Society of Arts last week, upon "Typological Museums," as exemplified by the Pitt-Rivers Museum at Oxford and his provincial museum at Farnham, Dorset. He advocates evolutionary arrangement in a large rotunda, and incidentally mentions that his museum, although in the country, was visited by 7,000 persons a year. At the conclusion of his paper General Pitt-Rivers exhibited a number of diagrams illustrative of the evolution of the modern rifle and bullet through all its stages, some of which had dropped out of public knowledge; and in connection with this he suggested the desirability of a similar series being arranged, before it was too late, of various electrical appliances, many links in which might be easily forgotten.

The Kimberley Exhibition.—The executive of the Kimberley Exhibition having invited Lord Knutsford to become patron of the exhibition, have received a communication from him intimating his readiness to act in that capacity. Messrs. Rodwell and Co., Port Elizabeth, and Devine, Gates, and Co., Capetown, are appointed forwarding agents for the exhibition. The plans of the buildings are now being decided upon by the committee. The prospectus of the exhibition has, we learn, been received by Mr. Atkinson, the London manager. It states that all European exhibits will be conveyed from the coast to Kimberley and taken back to Port Elizabeth or Capetown free of charge. Medals and certificates will be specially awarded for the most economical mining, electric lighting, and agricultural machinery. Special prominence is to be given to all classes of machinery adapted for use in the colony.

Private Bills.—Monday being the last day for the deposit of private Bills at the Private Bill Office of the House of Commons, there was a large attendance of parliamentary agents who have charge of schemes for the coming

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USING UP ACCUMULATORS.

Whatever electrical engineers may say, or whatever they may wish, it will remain a fact in electric tramway questions that the objections, real and unreal, to overhead conductors, and the difficulties with underground or closed conduits, leave a large field open in tramway work, which, if it is to be satisfactorily conquered by electric traction at all, must be conquered by accumulator traction. This will be so for two reasons—first, that the well-known difficulties of introducing direct current into crowded English towns militates in favour of self-contained cars; and secondly, the equally well-known fact that the tramway companies in general have no capital to spare for alterations favours the gradual introduction of electric traction which can best be brought about by self-contained storage cars working among the ordinary horse cars. Against all this there is the great and primary question of the cost of running, which so far has seemed to weigh very much in favour of the direct-current systems. In actual efficiency, if the figures were practically tested, we doubt whether there is much to be said greatly in favour of either, for recent tests on American lines seemed to show that overhead direct-current lines only usefully employed 50 per cent. of the brake engine power generated, while accumulator cars cannot be much below this efficiency. With these rival systems, therefore, the question resolves itself into a three-cornered fight of convenience, first cost of plant, and current cost of running. Of these the last is the determining factor, and this in accumulator work resolves itself into one of depreciation of batteries.

It is open to very decided question whether electrical engineers have not been working upon the wrong tack in attempting to lengthen the life, perfect the working machinery, so to speak, of the accumulator, and whether it would not pay better to attend less to the beauty of manufacture of storage plates and more to their strength and cheapness, even if less long lived. In a word, to put the matter in plain light, should we use accumulators as watches or as fuel? Should we polish, and manœuvre, and scheme that we may get the most perfect action, the most long-acting chemical machine; should we treat the storage cell, in fact, as if it were a delicate machine to be treated with the utmost care and delicacy, or had we better rather consider the lead plates as so many tons of fuel to be purchased as cheaply as possible and used to their utmost for the six, eight, or twelve months and then cast aside for new ones?—consider the lead, in fine, as a part of the fuel and not as a part of the plant. To do this would need a very different attitude both of accumulator manufacturers and of the users of the cells. But this might be done, we think, by the introduction of a plate requiring the minimum of formation and manufacture, of which, in fact, the ordinary lead of commerce is the principal cost. We alluded last week to a new cell invented by Mr. Reckenzaun, which promises well in the direction we have ventured to suggest. This plate is made direct out of plain lead strip, previously oxidised on the surface by the ingenious method of passing it through an electric arc; the strips are roughly tacked together, forming a plate capable of being knocked about without fear of breaking, or over-discharged without fear of buckling. The plate is therefore a simple Planté cell, manufactured and formed with the smallest cost for labour. We have seen plates which have been worked for eighteen months and are still in good condition. Mr. Reckenzaun has been zealously working upon this question for some years, and we certainly think he has made a distinct advance towards the proper treatment of storage cells as a rough, electrical engineering and not a delicate, electrican's question. Without saying that the grand problem of a cheap and efficient accumulator is definitely solved, it seems as if a light were shining from the point we desire to see it, and we hope it is true, as we hear, that the manufacture of these lead strip accumulators will be taken up in a commercial spirit—and that they will prove successful. Accumulator traction will receive the impetus for which we have all been so long waiting, when, as we have said, the plates can be used up as fuel rather than tended as delicate machinery.

CURRENT "FROM THE MAIN."

This is the title of an article in the *Lancet* of December 19th, by W. S. Hedley, M.D. We reprint it elsewhere, inasmuch as the object of every electric light supply company is to pay a dividend, and in order to do this it must sell current whenever and wherever possible. The idea so many electrical engineers take, that in the first place undivided attention must be given to the distribution of current for light, is so much lost opportunity. It is not only light, it is use in every direction that is wanted. Once get the terminals inside a house, and then prove to the inmates that it is not light only, but—well, whatever else is wanted in the house. Electrical apparatus is the most suitable of all, and for almost everything. Let us take one example. Hitherto bars and bolts have been the grand means of keeping our houses safe from depredation. Burglar alarms have been fixed, but in our opinion all such alarms have erred on the side of complexity. A burglar must walk, and two or three "tread" alarms would be far more effectual than apparatus at each door and each window. The alarms could be made part and parcel of the bell system of the house, could by the turn of a handle be put into or out of circuit—that is, could at a fixed time at night come into play, and be cut out in the morning. No doubt an inmate of the house might avoid the various "treads," but with such a restricted area for police work detection would be comparatively easy. It might be found advisable to have the safety devices separate from the bell system, and to put the apparatus in a circuit direct from the house terminals. There would be no difficulty in such an arrangement. It requires, however, some energetic men from America, or some patentees of a foreign nationality, to come over here and promote a company to float apparatus of this character upon a market that is ready to be exploited. A patented article—patent valid or invalid matters not—is the only article that will go down with business men. Few will be found to say: "Make my house or office safe," but will buy any nostrum that is presented to them in the form of a patent. However, this suggestion is only introduced for the purpose of hinting at a huge undeveloped field of business which someone will have to explore. Dr. Hedley refers to another field—the use of current for surgical and medical purposes. The simple question for the doctor is, Can the current be kept under control? In the majority of cases where current is used the answer may be unmistakably in the affirmative. In other cases the variations of resistance are excessive, and here lies the difficulty. It may be remembered that some years ago electric cautery was pronounced in some quarters to be the grandest discovery of the age for surgical operations. But we hear little or nothing of electric cautery now. You may easily render and keep a platinum wire white hot, but on bringing that wire into contact with moist flesh the resistance of the circuit is altered, and the wire with the same cells may not even reach a red heat—a heat altogether too low for the purpose for which it is wanted. Assuming, however, that in most cases where the electric current is required, and a continuous current is available, will a better method be found than by taking the current required from a secondary battery? Whatever we may come to later, we do not yet charge such batteries from alternate-current mains, so that when these are installed other apparatus is necessary. While, then, it may be profitable to instal hundreds of lamps, a few shillings may be picked up by supplying the wants of doctors and of dentists. Anything that helps to bulk out that load curve ought to be welcome.

SAVORY v. LONDON ELECTRIC.

The judgment of Mr. Justice Kekewich in this case will be read with considerable interest. It is almost needless to say we cannot quite agree with it. One sentence in the judgment is exceedingly strong. It reads: "That there is now no imminent danger against which the plaintiffs are entitled to protection is clear beyond dispute." If this means anything, it means that the defendants have taken every precaution to obviate the danger; and the adverse judgment cannot be taken as against the work of the defendants as it now stands, but is based upon the position of affairs at the time the action was commenced, and the lack of knowledge we have of the unknown. The latter cannot well be remedied, nor can industrial third column also, in order to be able to make comparisons. It will be seen from this column that the Tudor accumulator, which is practically a Planté cell, is one of the heaviest—that is, having the least ampere-hours per pound, but it is, however, not much heavier than the "Hagen" type. The next column gives the discharge in amperes per pound of plates, which, it will be seen, varies between about one-third of an ampere and one ampere, and is very high for the Julien cell, which is due chiefly to the high capacity per pound of these cells, as shown in the second column. The fifth column corresponds to the fourth, but is reduced to amperes per pound of cell, because some of the makers did not state the weight of their plates. Here, again, it will be seen that the figures for the Tudor accumulator are low, but compare very favourably with those of Hagen. Those of the Julien are again high, and those of the Oerlikon Company are also very high, notwithstanding the fact that they have a solid electrolyte.

These four columns, in which the figures depend on the weight of the cell, are of interest only when the weight of the cell is an important feature, as, for instance, for traction purposes, or for portable cells, but for stationary cells, such as those used for lighting buildings and at central stations, the weight of the cells is of absolutely no importance. In fact, it may almost be said that the heavier the cell is the less likely it will be to go to pieces, provided the material is placed where it is most needed. Great capacity per pound is therefore of little importance for stationary work.

The sixth column gives the rapidity of the discharge in hours. It will be seen from this that a discharge in three to three and a half hours, which used to be considered abnormally rapid, is now quite common in Germany. With such heavy discharges, the capacity is, of course, diminished, as we saw in the curves above referred to, but the capacities given in the first column are those which correspond to the discharges given in the sixth column.

The next column is perhaps the most interesting to the purchaser of an accumulator. In this column we have reduced the costs to cents per ampere-hour, in order that the figures may be compared with each other. The list prices were taken, because they were the only ones which could be obtained, and some allowance must, therefore, be made in interpreting the figures. As a rule the prices are naturally higher for smaller capacities, but as a general average seven cents per ampere-hour may be taken (excluding that of the Accumulator Company, which is exceptionally high) for about 100 ampere-hours; for about 500 ampere-hours the average price is about six cents, while for 1,500 it reaches as low as 4½ cents. In order to compare our American accumulators with those at the exhibition, we have added here the figures of two of our principal companies.

TABLE II.

—	A.	B.	C.	D.	E.	F.
Original Plantécell of 1860	17·15	7·25	—	—	—	—
Huber	90·	6·8	1·0	6 9	5·9	Glass.
Gadot	93·5	4·5	·87	5·2	6·6	—
Faure-Sellon-Volkmar ...	100·	7·5	·91	5·0	7·7	Ebonite.
Pollak	100·	3·2	·63	5·0	8·7	Wood.
Garassino................	100·	6·	·90	6·7	5·8	—
Schoop (Oerlikon)	115·	2·7	·48	5·8	6·5	Glass.
E.P.S.	120·	—	—	3·0	9·3	Wood.
Elwell & Co. (copper-zinc)	200·	39·	4·9	8·0	3·1	—
„ „ reduced to 2-volt cells	200·	13·	—	8·0	9·3	—
Cèly (Sarcia)	250·	4·5	·45	10·0	6·8	—
Faure-Sellon-Volkmar ...	400·	4·6	·69	6·7	4·3	Composition.
Pollak	400·	3·2	·63	5·0	5·3	—
Garassino......................	400·	6·1	·91	6·7	3·9	—
Gadot	475·	3·2	·67	4·8	5·9	—
E.P.S.	500·	—	—	11·0	4·35	Glass.
Cély (Sarcia)	500·	4·5	·45	10·0	5·8	—
Schoop (Oerlikon)	500·	2·5	·45	5·4	4·8	Glass.
Huber	565·	7·1	·69	10·0	4·3	Glass.
Faure-Sellon-Volkmar ...	2,000·	4·5	·68	6·7	3·9	Composition.
Cély (Sarcia)	2,000·	4·5	·45	10·0	4·3	—
Elwell & Co. (copper-zinc)	2,100·	41·0	6·2	7·0	2·0	—
„ „ reduced to 2-volt cells	2,100·	13·7	—	7·0	6·0	—

A. Capacity in ampere-hours. B. Capacity in ampere-hours per pound of plates. C. Rate of discharge in amperes per pound of plates. D. Rapidity of discharge in hours. E. List price in cents per ampere-hour capacity. F. Nature of cell.

In this connection it may be of interest to compare these figures with those of a similar table compiled for the accumulators at the Paris Exposition of 1889. As a matter of interest we have added here the figures for the original Planté cell of 1860 which was exhibited at this exhibition, and it will be seen, strange to say, that the capacity per pound is higher than any of the others, of either the Faure or Planté types. It is likely, however, that this figure—viz., 7·25—represents a discharge which was carried considerably farther than is usual in practice, and that therefore it is not quite fair to compare it directly with the others; but even if it were corrected it would probably still remain among the highest.

The accumulators in this table were either of the Planté or the Faure type, except the one exhibited by Elwell and Co., which is a copper-zinc accumulator, otherwise known as the Lalande and Chaperon alkaline, or in this country as the Waddell-Entz. It has an E.M.F. only about one-third that of the lead accumulators, and the figures for it have therefore been reduced, as shown, to two-volt cells. Even then their capacity per pound appears very great, but it is a question whether the published data were as reliable as those of the other companies.—*Electrical World* (New York).

THE MEASUREMENT OF THE RESISTANCE OF CONDUCTORS CONTAINING DISTURBING E.M.F.'S.*

BY ROLLO APPLEYARD.

(*Concluded from page 564.*)

In this case the value of E was practically one volt. The table shows the values of e in the above experiments, calculated from (9), for different days.

TABLE III.

x	d	d^1	e	Date.
$x + y$	341	490	·034	3/6/91
$y + z$	1,195	2,890	·221	
$z + x$	2,577	807	·253	
$x + y$	344	489	·033	4/6/91
$y + z$	1,235	3,019	·227	
$z + x$	2,690	830	·262	
$x + y$	340	491	·034	5/6/91
$y + z$	1,241	2,974	·222	
$z + x$	2,655	842	·255	
$x + y$	336	401	·035	6/6/91
$y + z$	1,207	3,071	·237	
$z + x$	2,749	818	·269	
$x + y$	333	483	·034	9/6/91
$y + z$	1,244	3,020	·226	
$z + x$	2,715	842	·262	

The galvanometer employed was the same as that used in the previous experiments with the bridge, a long-coil Siemens reflecting instrument of India service pattern. The key is made with broad surfaces of contact. The ordinary B.A. bridge key can be readily adapted to the purpose by the addition of an extra spring between the upper contacts.

An inspection of Table III. shows fairly well that the E.M.F. of an earth-plate, and its resistance, does not vary appreciably within the limits of time required, by this method, to carry out a test. We may call these values the "initial E M.F.," and the "initial resistance," respectively. By the tangent galvanometer method the change in the E.M.F. is very considerable. In order to compare these an independent measure was taken, using a galvanometer of about 6,000 ohms resistance as a voltmeter. When connected through 100,000 ohms between the plates x and z, the change in E.M.F. was found to be nil. To reproduce the tangent galvanometer arrangement, the reflecting galvanometer was shunted so that its resistance was about equal to the tangent galvanometer, the 100,000 ohms being removed. The deflection, of course, diminished rapidly, losing about one-sixth its initial value after one minute, one-fourth its initial value after 2½ minutes, one-third its initial value after 10 minutes.

If we use the method of instantaneous taps with a sensitive galvanometer and a multiplying ratio, we can make a close examination of the plates at any time. When balance is very nearly obtained, we can watch the polarisation effects, if we please, by keeping the key down; we can also note how soon the polarisation effects vanish after the causes that produced them are removed, and how soon the "initial resistance" is regained.

For practical work with earth-plates we do not want to spend time in speculations of this kind. The galvanometer need not be very sensitive, nor the multiplying ratio very high. We want the truth, but not to the "fifth decimal."

It is otherwise, however, when there is an electrolytic resistance to be measured; or when using the method for comparing the E.M.F.'s of easily polarisable cells by formula (9); or again, when, for very high resistances, a dividing ratio has to be used at the arms $a\,b$.

---

* Paper read before the City and Guilds Old Students' Association.

There is uncertainty with liquid resistances, arising from changes in density, composition, and purity, and a doubt also regarding the nature of contact between the liquid and the electrodes. I believe, however, that the method of taps will be found of great use in these determinations. If the nature of the conductor or electrolyte is such that the disturbing E.M.F. is variable, it is necessary to arrange the bridge so that d and d^1 may be obtained, as nearly as possible, simultaneously. For this purpose I have used two boxes of resistance coils in the variable arm, each provided with a short-circuiting plug, so that one can be cut out when the other is in. The resistance of one of the boxes is approximated to for two trial taps. This box is now plugged up, and the second box unplugged, the testing battery being reversed. The second box is now adjusted as nearly as possible for two trial taps. This has to be repeated until d and d^1 are obtained.

If the electrolyte, or resistance under test, is very easily polarised, even by the instantaneous current, a difficulty appears in judging the right values of d and d^1. Consider what happens when the circuit is completed, the variable arm, d, being a little too much. When the key is depressed and kept down, there will be a momentary deflection in the direction indicating "d too much," followed immediately by a motion in the reverse direction, making d apparently "too little." We can evidently find a value for d at which the first effect will just vanish. This is to be taken as the proper reading. It is important to observe that the same order of deflections occurs whatever be the direction of the testing battery. The secondary deflection, which is, of course, due to polarisation in the x branch of the bridge, always acting in a direction indicating "d too little."

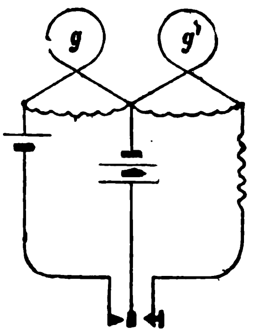

FIG. 9.

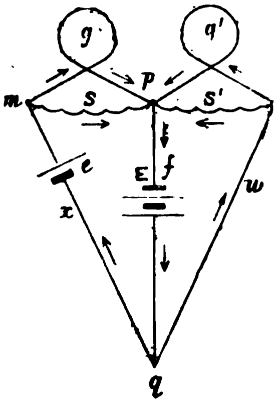

FIG. 10.

The explanation is simple. Referring to Fig. 5, we see at once that it is E, and not e, which determines the directions of the currents in the various arms of the bridge. So that E, and not e, defines also the directions of the polarisation currents in the arm x. We may assume e, the initial E.M.F., to act as an added or subtracted resistance according to its direction with respect to E. Polarisation effects will always act in a direction indicating "d not enough" for opposing E.M.F.'s are equivalent to added resistances. If, then, d is adjusted to the value corresponding to the initial resistance of x, any depression of the key long enough to cause polarisation will increase the apparent resistance of the unknown arm, and will make the variable arm "not enough." As long as d is greater than the value corresponding to the initial resistance of x, there will be, on depressing the key, a momentary deflection in the direction indicating "d too much," followed by the reverse deflection if the key is kept down long enough to cause the polarisation currents to start in the x arm. Consequently the only correct value for the variable arm is the value at which the first motion, indicating "d too much," just vanishes.

Now, I want to put before you the difficult combination of an inductive resistance in circuit with a polarisable one. This arose on one occasion when a line test was being made; the relay at the distant station had considerable inductance, being magnetically polarised, and the earth-plates had polarisation of the kind represented by another meaning of that ill-used term. If the tap was made very suddenly, there was a sudden deflection arising from the inductance at the relay. It was scarcely to be mistaken for an electrolytic polarisation effect, being more rapid than those which earth-plates generally produce. The obvious way of removing the difficulties is to tap deliberately rather than suddenly. It may be well to observe that with an ordinary Wheatstone bridge, with the best of B.A. keys, the key does not remove the effects of inductance for very sudden taps. At the present price of platinum, another factor comes in here also—the wear and tear of contacts, caused by taps too sudden and energetic.

Applying the detaching principle to the differential galvanometer, we obtain an alternative method, which it is possible might be of service in a special case. Fig. 9 shows the way in which the three branch circuits are separated out. In this instance a key with three contacts would be employed. Here we are not dealing with steady currents through the galvanometer, and consequently only approximate results are to be expected, unless we can ensure that each coil of the galvanometer, together with its shunt, has the same induction coefficient. As this will seldom be the case, I suggest the device simply for what it is worth. The complete formula may be arrived at as follows:

Let E = E.M.F. of testing battery; f, its resistance; c = E.M.F. in the arm, x.

Denote the resistances of the various branches by small letters, and the corresponding currents by capitals.

We have

$$G\,g = S\,s \quad (1); \qquad X = S + G \; \ldots\ldots \; (3)$$

$$G'\,g' = S'\,s' \quad (2); \qquad W = S' + G' \; \ldots\ldots \; (4)$$

$$F = X + W \; \ldots\ldots \; (5)$$

In ordinary differential galvanometers $g = g'$ . . . . . (6)

When balance is obtained $G = G'$ . . . . . (7)

$$\therefore G\,g = G'\,g' \; \ldots\ldots \; (8)$$

From (1) and (2), $S\,s = S'\,s'$ . . . . (9)

In the circuit m, n, q, m,

$$e = X\,x + S\,s - S'\,s' - W\,\omega$$

From (9) $e = X\,x - W\,\omega$ . . . . (10)

From (2), $\dfrac{G'}{S'} = \dfrac{s'}{g'} \therefore \dfrac{S' + G'}{S'} = \dfrac{s' + g'}{g'}$

$\therefore$ From (4) $\dfrac{W}{S'} = \dfrac{s' + g'}{g'}$. Or $S' = W\dfrac{g'}{s' + g'}$ . . . . (11)

In the circuit p, n, q, p,

$$E = F\,f + W\,\omega + S\,s'$$

$\therefore$ From (5) and (11)

$$E = X\,f + W\,f + W\,\omega + W\frac{s'\,g'}{S' + g'} \quad . \; . \quad (12)$$

From (1)

$$\frac{S}{G} = \frac{g}{s}, \therefore \frac{S + G}{G} = \frac{s + g}{g}, \therefore, \text{ from (3), } \frac{X}{G} = \frac{s + g}{g} \quad (13)$$

Similarly,

$$\frac{W}{G'} = \frac{s' + g'}{g} \; \ldots\ldots \; (14)$$

From (7), (13), and (14),

$$\frac{W}{X} = \frac{\dfrac{s' + g'}{g'}}{\dfrac{s + g}{g}} = k \; \ldots\ldots \; (15)$$

$$\therefore W = X\,k \; \ldots\ldots \; (16)$$

(10) may now be written,

$$e = X\,x - X\,k\,\omega \; \ldots\ldots \; (17)$$

and (12) becomes

$$E = X\,f + X\,k\,f + X\,k\,\omega + X\,k\frac{s'\,g'}{s' + g'} \quad . \; . \quad (18)$$

$$\therefore \frac{e}{E} = \frac{x - k\,\omega}{f + k\,f + k\,\omega + k\dfrac{s'\,g'}{s' + g'}} \; \ldots \; (19)$$

Reverse the testing battery, obtaining ω' for ω, and $-E$ for E.

$$\therefore \frac{e}{E} = \frac{k\,\omega' - x}{f + k\,f + k\,\omega' + k\dfrac{s'\,g'}{s' + g'}} \; \ldots \; (20)$$

Add numerators and denominators, respectively, of (19) and (20).

$$\frac{e}{E} = \frac{k\,(\omega' - \omega)}{2\,f + 2\,k\,f + k\,(\omega' + \omega) + 2\,k\dfrac{s'\,g'}{s' + g'}} \quad . \; . \quad (21)$$

Subtract ditto.

$$\frac{e}{E} = \frac{2\,x - k\,(\omega' + \omega)}{k\,(\omega - \omega')}$$

Or

$$\frac{e}{E} = \frac{k\,(\omega' + \omega) - 2\,x}{k\,(\omega' - \omega)} \; \ldots\ldots \; (22)$$

Equating (21) and (22), we have,

$$x = k\,.\,\frac{\omega' + \omega}{2} - \frac{k^2\,(\omega' - \omega)^2}{2\left[2\,f + 2\,k\,f + k\,(\omega' + \omega) + 2\,k\dfrac{s'\,g'}{s' + g'}\right]}$$

In England the earth-plate is scarce. You will enquire for them in vain at the G.P.O. in Aldersgate-street. The gas and water companies, in a truly generous spirit, provide us, in the pipes which they lay at our feet, with a substitute excellent in efficiency, and, what is perhaps more important, costless to maintain, at least from our point of view.

But abroad, as in India or Persia, their importance is extremely great, and the earth-plate test is a regular part of the telegraphist's routine.

It has been suggested that a series of careful tests of the resistance of plates of the same dimensions, and planted in the same way, at fixed depths and distances, in strata of different geological character, would be of service in indicating the nature of the intervening rock. And it would appear that some such method as this offers the only means of investigating the direction and duration of earth currents proper, of which at present scarcely anything definite is known.

COMPANIES' MEETINGS.

ELECTRIC CONSTRUCTION CORPORATION.

A general meeting of this Company was held at Cannon-street Hotel on Tuesday last, Mr. Spencer Balfour in the chair. After the Secretary had read the notice convening the meeting,

The **Chairman** said the duty devolved upon him to propose the adoption of the report, owing to the regrettable absence of their esteemed friend Sir Henry Mance, who had within the last fortnight undergone a very painful operation. He was, however, near convalescence, and inasmuch as the illness was largely aggravated by devotion to the interests of the Corporation, he thought shareholders would agree in wishing him a speedy and complete recovery. He (the speaker) thought he must be grateful that the task had fallen to him, because in view of the satisfactory character of the report there would be no difficulty in obtaining the shareholders' approval to the resolution which he should move. He would go briefly through a few of the more striking features of the report, and when that was done he would conclude by making a few remarks on the general prospects of the undertaking. Dealing with the question of profits and the results achieved during the year, they would see by sales and work executed during the year ended September, 1891, a total of £160,036. This, of course, represented a large figure, and was proof that during the whole year their works had been fairly busy. It meant something like £3,000 a week on work alone of a manufacturing character. The next item in the account was cash and shares for licenses granted, patents sold, the profits upon formation of subsidiary companies. That item of £64,710 was important, and he wished to point out that it represented nearly all profit, and was therefore most gratifying. The patents which had been sold were not included in the original purchase from Elwell-Parker. There had been developments of patents which at that time were floating through the mind of their extremely able engineer and work director, Mr. Thomas Parker. These patents had been sold, or licenses had been granted to use them. In selling these patents they had not in any way diminished the securities which were acquired when the works were taken over. They were additional profits and securities acquired since that time, thanks to the genius of Mr. Parker. Out of the sum of £64,710 they had written off no less amount than £20,000, which was carried to diminution of capital account. He ventured to think that that was a precedent policy, and if they persevered for a few years to come, and if the sales and payments in respect to patents continued, which he had every reason to think would, the result would be that capital charges would be materially reduced, thus adding largely to the Company's capacity to pay a dividend. This year they proposed to write off £20,000, or one-third of the total amount received from the patents, as was mentioned before, to the diminution of capital, and they would see it so appear in the balance-sheet. After that there still remained a profit of £44,790. Referring to the profit and loss account on the other side, the shareholders would see that they had debited themselves with £3,099 for depreciation of machinery. They had endeavoured to keep machinery up to the highest point of efficiency possible in order to make two charges for repairs to the working expenditure during the year. In that way they had spent, as they would observe, over £3,000, although at the same time they had deducted £10,000 in profit and written it as depreciation of machinery, which they would observe. As prudent men, they had adopted a double course—£10,000 they set aside to meet depreciation of machinery, and they had spent £3,000 in preventing any depreciation of machinery arising. That was a good course, and was a singular course for Directors to take. He thought in this respect they might fairly claim to have set an example to every manufacturing company in the City of London. Head office expenses, including Directors' fees, salaries, accountancy fees, etc., stand at £11,423 7s. 1d. At the last meeting the amount of office charges was challenged, and he (the speaker) said it would be part of his duty to keep them down as low as possible. Shareholders would observe that for the last year they had amounted to £11,000, as against £14,000 during the previous year. This was a proof, he thought, that he had kept his word to the shareholders, and that the Directors were really anxious to keep down the dead charges of the Company. Expenses of advertising, issuing debentures, law charges, etc., amounted to £13,110, which was a considerable increase upon the expenditure of the previous year. This was largely owing to the fact that during this year they had issued debentures, and a big debenture issue was not made without expense. The charges for this might have been spread out, if they had chosen, over two or three or even four years, but they preferred to bring it into the current year's account and get rid of it once and for all. In addition to that, there were heavy legal expenses which they incurred from time to time in asserting and maintaining the Company's position, and asserting and maintaining the position of the patents. He would promise to the shareholders vigilance on the part of the Board to keep this expenditure down, but he could not promise—while competition was so keen, and while their opponents were so willing to take every advantage, fair and unfair, of the Company—any material reduction on legal expenses. A company of this sort lived by proving its capacity for fighting, and its capacity for maintaining the rights of the shareholders in the various properties in which they are interested. They had, he ventured to think, as good, if not better, legal advice than was to be found within the City of London. They got ample value for the money they spent in lawyers' bills, but it was generally the least satisfactory thing a man had to deal with. There had resulted a general profit of £46,000, but of this £10,000 had been carried to reserve, leaving a net balance of £36,166. He then referred to the transactions during the year (which were some of the most interesting transactions that a Board could undertake) in dealing with what he would call the electro-chemical patents, for which they were indebted to the marvellous ingenuity of Mr. Parker. He would here take the opportunity to remark that instead of purchasing, as was often the case, less than was bargained for, when they took over the Elwell-Parker, business, they had purchased a good deal more than they bargained for. They had derived these electro-chemical patents, which were then not valued at a farthing. So valuable and accruing a possession were these electro-chemical patents that they thought it wise to place them in the hands of a separate company, and their friend and colleague Mr. Ebbsmith, who was managing director of the Electric Construction Company from the beginning and had practical experience of the negotiations attending these electro-chemical patents, elected to become the presiding genius of the Electro-Chemical Company. He would mention as one illustration of the success which had attended the floating of this Company in which they were the largest holders, that during the last few days they had sold one of these electro-chemical patents for a sum in hard cash representing close on £30,000, and was a contingent profit of many tens of thousands besides, and this was largely owing to the fact that Mr. Ebbsmith had had time to devote exclusively to working the patents. In a business of this sort he considered that they should not have too much subdivision, and the working of the chemical patents was quite a business by itself. The vast establishment which they now had at Wolverhampton was quite a business which claimed the energy and occupied the time of the very best men they could place there, and the same applied to electrical storage batteries. They found that they were not holding their own in the storage battery field in doing as much work as they had hitherto done. Mr. Courtney, whose life had been identified with storage batteries, agreed to take up the storage batteries in a separate company; and the result had been that the business has grown, and since it has been placed in separate hands it had yielded a very large profit. Therefore, while union of interests, union of aims, union of working were of the utmost importance, and a vital condition of this Company, independent management of independent branches was equally valuable and was equally important. He would here express his thanks to Mr. Courtney for the service which he had rendered to the Corporation. Considerable change in the staff had been involved by the retirement of Mr. Ebbsmith, and he was pleased to say that the work was carried out most successfully and economically under the direction of Mr. Samson, to the benefit of the shareholders. The speaker then referred to the services of Mr. Parker in supervising the establishment at Wolverhampton, and the active part he had taken in perfecting the patents. Mr. Parker was recognised more and more every day as the greatest living authority in manufacturing electricity. Perhaps the biggest electrical work carried out in this country was the Liverpool Overhead Railway, which was to be worked throughout by electricity. The Directors had no particular interest in that company, and in an entirely open field Mr. Parker's plans were accepted, and the Corporation was now carrying out the contract, from which he believed there would be a large profit. They were dealing with the question of the electric lighting of the city of Oxford, having accepted a contract from the city authorities, and were also supplying the plant to a company formed for supplying electric lighting in the Crystal Palace district. He thought he had now dealt with the salient points of the position; but, turning to the balance-sheet, he would just point out again that they set aside £15,000 last year for depreciation and had added £10,000 this year, which made £25,000 as a reserve for depreciation. They had written off their capital account £3,000 for depreciation of machinery, and transferred from profit and loss account £20,000 for the same purpose, while they had reduced their capital charges from £312,800 to £289,700. With regard to the subsidiary companies in which they had taken shares, he found that there was not one of them but which had either paid a dividend or was about to do so. The shares were, therefore, a good investment *per se*, in addition to the advantage to them that they were thus enabled to secure the business which the subsidiary companies were able to bring. Before sitting down he would like to mention that since the publication of the report the Company had had some very important negotiations with regard to electric traction, having been approached by one of the leading tramway companies, who considered that electricity was to be the motive power of the future, and had offered them a contract which they were now considering. If they should decide to accept the contract—and he believed they would—they would come to the shareholders to secure a further issue of debentures. The Company were full of work, and the Directors were proud of the operations that had been carried on. They appealed to the shareholders to give them their continued confidence, and he firmly believed they would be able to make the undertaking even more successful than it had hitherto been.

Sir Daniel Cooper, G.C.M.G., seconded the motion.

Mr. Hancock complained of the want of detail in the accounts.

Mr. Oelrich congratulated the Directors on the management of the Company and the very satisfactory report they had put before the shareholders. He thought that to declare a dividend of 6 per cent. in the first year and the same amount in the second was a very promising state of things in the early days of a Company like this.

Dr. Drysdale asked whether the tramway to which the Chairman had referred as being about to adopt electrical traction was in London.